(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 0 726 155 B1

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
28.08.2002 Bulletin 2002/35

(51) Int Cl.[7]: **B41J 2/21**

(21) Application number: **96300032.8**

(22) Date of filing: **03.01.1996**

(54) **Ink-jet head, ink-jet cartridge, printing apparatus, and ink-jet printing method**

Tintenstrahlkopf, Tintenstrahlpatrone, Druckgerät und Tintenstrahldruckverfahren

Tête à jet d'encre, cartouche à jet d'encre, appareil d'impression et méthode d'impression à jet d'encre

(84) Designated Contracting States:
DE FR GB IT

(30) Priority: **13.02.1995 JP 2390995**
21.12.1995 JP 33383295

(43) Date of publication of application:
14.08.1996 Bulletin 1996/33

(73) Proprietor: **CANON KABUSHIKI KAISHA**
Tokyo (JP)

(72) Inventors:
- **Hirabayashi, Hiromitsu,**
  c/o Canon Kabushiki Kaisha
  Ohta-ku, Tokyo (JP)
- **Sato, Shin'ichi, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)
- **Moriyama, Jiro, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)
- **Kato, Masao, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)
- **Inui, Toshiharu, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)
- **Kato, Minako, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)
- **Sugimoto, Hitoshi, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)
- **Tajika, Hiroshi, c/o Canon Kabushiki Kaisha**
  Ohta-ku, Tokyo (JP)

(74) Representative:
Beresford, Keith Denis Lewis et al
BERESFORD & Co.
2-5 Warwick Court,
High Holborn
London WC1R 5DH (GB)

(56) References cited:
EP-A- 0 137 313
JP-A- 61 249 755
US-A- 4 538 160
US-A- 5 181 045

EP 0 726 155 B1

Description

[0001] This invention relates to an ink-jet head, an ink-jet cartridge, and an ink-jet printing apparatus using the devices, and an ink-jet printing method, more specifically, applied to ink-jet printing for discharging a printing ink and a print improving liquid for insolubilizing and coagulating a color material in the printing ink.

[0002] The present invention can be applied to all types of devices using printing media such as paper, cloth, leather, non-woven fabrics, OHP sheets, metals, or the like. Practical examples of applicable device include office machines such as printers, copiers, and facsimiles, and industrial production apparatus.

[0003] Heretofore, ink-jet printing method has been utilized in printers and copiers for its low-noise, low running cost, and compact design features, and ease to be applied to color printing.

[0004] However, when obtaining an image on a printing material, which is so-called plain paper, by these printing devices using the ink-jet printing method, the image tends do be insufficient in water resistance, and when a color image is obtained, it is impossible to obtain a high-density image with no feathering nor blotting between colors, and a high quality color image with good fastness has not been obtained.

[0005] To improve the water resistance of the image, recently an ink containing a water-resistant color material has been practically used. However, its water resistance is yet insufficient, and since the ink in principle becomes water-insoluble after drying, the print head nozzle tends to be clogged, it is insufficient to solve the problem simply by improving the structure of the conventional head or ink-jet printing apparatus, and the apparatus capable of using the print improving liquid tends to be complex in structure.

[0006] Further, a number of techniques for improving the fastness of the printed matter have been disclosed. Japanese Patent Application Laid-open No. 24486/1978 discloses a technology in which a dyed matter is treated to convert the dye into a lake for fixing to improve the wet fastness of the dyed matter.

[0007] Still further, Japanese Patent Application Laid-open No. 43733/1979 discloses a method using an ink-jet printing system which uses two or more ingredients increasing in film-forming ability at room temperature or when heated, wherein the individual ingredients contact with each other on the printed matter to form a securely fixed film.

[0008] Japanese Patent Application Laid-open No. 150396/1980 discloses a method which uses an aqueous dye ink and a water-resistant agent to form a lake with the dye after ink-jet printing.

[0009] Yet further, Japanese Patent Application Laid-open No. 128862/1983 discloses an ink-jet printing method in which the position of image to be printed is previously determined and the printing ink and a treatment ink are overlappingly printed, and also discloses a method in which an image is depicted with the treatment ink before the printing ink, the treatment ink is overlapped on the printing ink previously depicted, or the printing ink is overlapped on the previously depicted treatment ink and further depicted with the treatment ink.

[0010] However, these patents do not disclose recovery means, head structure, or tank structure for reliability of constructing the ink-jet printing apparatus, nor head structure and print mode for improving the quality of the print image. Further, they do not describe the head structure or printing method for reducing the cost of the printing apparatus, nor printing method for reducing the running cost.

[0011] Specifically, the above prior art does not disclose the coating method of the print improving liquid, that is, the coating method by the ink-jet print head in detail, for example, it does not describe a problem of uneven coating due to the coating amount distribution by spray coating over the entire surface before or after printing, and unevenness over time due to a difference in penetration or fixing over time after printing by serial printing specific to ink-jet printing.

[0012] The method for printing the treatment ink by ink-jet printing only describes the relationship between the print improving liquid and the ink on the printed image, but does not describe detailed printing method (head structure, print mode, and devices) nor describe problems specific to ink-jet printing occurring in the method.

[0013] Any of the above patents does not describe bleeding between colors, bleeding due to difference in ink composition by letter quality and colors to achieve both letter quality and color printing, and white fogging as problems in color printing on plain paper by ink-jet printing, and problems with color printing (color difference due to the application order of color inks: dye distribution in the printing medium) by bidirectional printing to increase the printing speed.

[0014] Still further, on the construction of the ink-jet printing apparatus, there is no description of securing the reliability and means for reducing the apparatus cost by simplifying and reducing the structure and device size as possible.

[0015] Yet further, there is no description of a printing method for reducing the consumption of the print improving liquid, reducing the running cost, and improving degradation of image quality caused by application position deviation in multibus printing due to cockling.

[0016] As described above, with the conventional head structure, it is impossible to reduce the consumption of the print improving liquid, achieve the effect of the print improving liquid, and improve the printing speed in a pre-feed as a combination of a head for the print improving liquid with the conventional printing method (that is, the print improving liquid is applied before the ink), and/or a follow feed (that is, the print improving liquid is applied over the previously applied ink). In particular, it is impossible to forecast the effects of the pre-feed and/or follow feed (penetration control, bleed reduction, reduction of unevenness/stripes), head structure, printing method, and condition of ink immediately

after printing (the time to contact of the print improving liquid with colored ink, and penetration condition of the individual ink on the printing medium) and achieve the sufficient effects, and to maintain the effects to an extent, the printing speed must be reduced (including low-speed control of the drive frequency, and temporary interruption of printing), resulting in a reduction of printing throughput.

[0017] With a view to solve the above problems, a first object of the present invention is to provide an ink-jet head for optimally utilizing the pre-feed and/or follow feed in ink-jet printing.

[0018] A second object of the present invention is to provide a print control method (including image quality improving technique applying head control/image processing) for optimally utilizing the pre-feed and/or follow feed techniques.

[0019] Further, a third object of the present invention is to provide an optimal combination of ink (CMY/K/print improving liquid) for optimally utilizing the pre-feed and/or follow feed techniques in ink-jet printing and an ink composition thereof.

[0020] Still further, a fourth object of the present invention is to provide an ink-jet printing apparatus which achieves high-precision application of pre-feed and/or follow feed, thereby achieving both high-speed/high quality at a low cost and a low running cost.

[0021] In accordance with the present invention, there is provided an ink jet head comprising:

a first ink discharge portion for discharging an ink;
a liquid discharge portion for discharging a liquid containing at least a print improving liquid for rendering insoluble or aggregating a dye or a pigment in an ink; and
a second ink discharge portion for discharging ink,

characterised in that the first ink, liquid and second ink discharge portions are arranged in that order in a predetermined direction.

[0022] In the above construction, the first ink discharge head and the second ink discharge head may discharge inks of the same color, or the first ink discharge head and the second ink discharge head may discharge inks of different colors. In this case, as to the scanning direction, the first discharge head may be a first black ink discharge head, the second discharge head may be a print improving liquid discharge'head, and the third discharge head may be a second black ink discharge head.

[0023] Further, with respect to the scanning direction, the first discharge head may be a black ink discharge head, the second discharge head may be a print improving liquid discharge head, and the third discharge head may be a discharge head which integrates a plurality of inks differing in color from black, or with respect to the scanning direction, the first discharge head may be a first black ink discharge head, the second discharge head may be a print improving liquid discharge head, the third discharge head may be a second black ink discharge head, and the fourth discharge head may be a discharge head which integrates a plurality of inks other than black, or with respect to the scanning direction, the first discharge head may be a black ink discharge head, the second discharge head may be a print improving liquid discharge head, the third discharge head may be a cyan ink discharge head, the fourth discharge head may be a magenta ink head, and the fifth discharge head may be a yellow ink discharge head, or with respect to the scanning direction, the first discharge head may be a first black ink discharge head, the third discharge head may be a second black ink discharge head, the fourth discharge head may be a cyan ink discharge head, the fifth discharge head may be a magenta ink discharge head, and the sixth discharge head may be a yellow ink discharge head.

[0024] Further, in the above construction, the liquid discharge portion having a head construction including two or more liquid discharge heads for discharging the same color and having the same colors may be shiftedly arranged from each other in the main scanning direction, the sub-scanning direction, or both the main and sub-scanning directions by an odd number times of 1/2 the nozzle pitch of the discharge portion, or the liquid discharge portion having the same colors may be shiftedly arranged from each other in the sub-scanning direction by about 1/2 the nozzle pitch of the discharge portion.

[0025] Still further, the ink-jet head may have a unit structure in which head chips constituting the individual discharge head are incorporated in an integrated frame, or a plurality of types of the head unit structures of the head chips constituting the individual discharge head incorporated in an integrated frame may be combined.

[0026] Yet further, the ink-jet head may have an electrothermal converter as an energy generation element for generating heat energy to cause film boiling of the ink or the print improving liquid.

[0027] Yet further, the print improving liquid may contain a cationic substance comprising a low molecular weight component and a high molecular weight component , and the ink may contain an anionic dye, the print improving liquid may contain a cationic substance comprising a low molecular weight component and a high molecular weight component, and the ink may contain an anionic dye or at least an anionic compound and a pigment.

[0028] According to a second aspect of the invention, there is provided an ink jet printing apparatus for printing on a print medium by discharging ink onto the print medium, the apparatus comprising an ink jet head according to any

of claims 1 to 15.

[0029] According to a third aspect of the invention, there is provided an ink jet printing apparatus comprising a main unit and an ink jet head according to any one of claims 1 to 15 detachably mounted to the main unit.

[0030] In the apparatus of the above construction, an element for a facsimile may further be provided, an element for a copier may further be provided, or an element for a personal computer may further be provided.

[0031] Further, in the apparatus of the above construction, the ink-jet head having the plurality of discharge portions may be detachably provided from the apparatus main unit.

[0032] Still further, in the apparatus of the above construction, a plurality of types of the head unit structures of the head chips constituting the individual discharge head incorporated in an integrated frame may be combined and detachably provided on the same carriage, so that the individual head units are identified to achieve optimized control.

[0033] Yet further, the apparatus of the above construction may have print control means for forming an image in which the print improving liquid discharged from the liquid discharge portion is sandwiched between the inks discharged from at least one set of the colored ink discharge portions on the printing medium with respect to a direction vertical to the surface of the medium.

[0034] Yet further, in the apparatus of the above construction, the print improving liquid discharged from the liquid discharge portion may be placed at a position shifted by 1/2 picture element in the main scanning direction, or the sub-scanning direction, or both to the ink picture element on the printing medium. In this case, the print control means may be printable in 1-pass bidirectional printing, in 1-pass unidirectional printing, 2-pass bidirectional printing, 2-pass unidirectional printing, in N-pass (N is a positive number) bidirectional printing, or in N-pass (N is a positive number) unidirectional printing.

[0035] Yet further, in the apparatus of the above construction, the one set of colored inks sandwiching the print improving liquid may be the same or different in color.

[0036] Yet further, in the apparatus of the above construction, the one set of colored inks sandwiching the print improving liquid may have different compositions. In this case, in the different compositions, one may be a high-penetration type solvent composition which momentarily penetrates into the printing medium, and one may be an overlay type solvent composition which slowly penetrates into the printing medium.

[0037] Yet further, the print improving liquid may contain a cationic substance comprising a low molecular weight component and a high molecular weight component , and the ink may contain an anionic dye, and a cationic substance comprising a low molecular weight component and a high molecular weight component, and the ink may contain an anionic dye or at least an anionic compound and a pigment.

[0038] According to a fourth aspect of the invention, there is provided an ink jet printing method for producing a printed product characterised by using an ink jet head according to any of claims 1 to 15.

[0039] In the printing method of the above arrangement, the print improving liquid discharged from the liquid discharge portion may be placed at a position shifted by ½ the picture element in the main scanning direction, or the sub-scanning direction, or both to the ink picture element on the printing medium.

[0040] Further, in the printing method of the above arrangement, the coloured inks may be the same or different in colour.

[0041] According to a fifth aspect of the invention, there is provided an ink jet cartridge comprising an ink jet head according to any one of claims 1 to 15 and an ink tank provided detachably on said ink jet head.

[0042] According to a sixth aspect of the invention, there is provided a printed product comprising a print medium having an image formed thereon by ink provided from an ink jet head according to any one of claims 1 to 15, and a print improving liquid for rendering insoluble or aggregating a dye or a pigment in an ink, wherein said print improving liquid is sandwiched between at least one set of colored inks on the print medium.

[0043] In the printed matter of the above arrangement, the print improving liquid discharged from the liquid discharge portion may be placed at a position shifted by ½ the picture element in the main scanning direction, or the sub-scanning direction, or both relative to the ink picture element on the printing medium.

[0044] Further, in the printed matter of the above arrangement, the colored inks may be the same or different in color.

[0045] Still further, in the printed matter of the above arrangement, the amount of component of the print improving liquid present at the center may be more than the component amount of the individual inks sandwiching the print improving liquid.

[0046] According to a seventh aspect of the invention, there is provided a control device for an ink jet printing apparatus for printing on a print medium using an ink jet head according to any of claims 1 to 15, the control device comprising:

discharge control means for causing discharge of ink from the ink discharge portion, then causing discharge of liquid from said liquid discharge portion and then causing discharge of more ink from a discharge portion so that the print improving liquid is sandwiched between ink on the print medium with respect to a direction perpendicular to the surface of the print medium.

[0047] The improvement of printability in the present invention includes improvement of the density, color saturation, edge sharpness, quality of dot diameter, ink fixing, and weather resistance such as water resistance, light resistance, and the like, that is, the improvement of image preservability. The print improving liquid is not necessarily discharged separately from the ink, but may be discharged by mixing with an ink which does not interact with the print improving liquid among a plurality of inks.

[0048] The discharge portion (or discharge portion) in the present invention means a discharge nozzle array such as for the ink or the print improving liquid. Further, the head chip is a chip where the discharge portion is provided on a single substrate to form a discharge nozzle group, and a plurality of head chips are combined to form a head unit.

[0049] Further, the discharge portion is not necessarily formed on a single head chip, but includes one which is formed over different chips.

[0050] Still further, the ink jet head of the present invention is so-called an aggregate of discharge portions in the ink jet printing apparatus, which may be integral with or separate from the apparatus. When they are separate from the apparatus, the head unit is included, and the number of head chips in this case is not specifically limited.

[0051] With the above construction, the optimum head construction and printing method can be provided which achieve the full effects of the pre-feed /follow feed techniques. In particular, the printing method due to the head construction of pre-feed /follow feed combining the head construction and printing method can provide sufficient effects of pre-feed / follow feed techniques (penetration control, blotting prevent, improvement of fixing, feathering prevention, reduction of bleeding, reduction of irregularity/stripes, and the like), enables high-speed, high-quality printing with a low-cost apparatus structure, obtains a sufficient effect at a minimum consumption of the conventional print improving liquid, thereby reducing the running cost and the apparatus size.

[0052] The above and other objects, effects, features and advantages of the present invention will become more apparent from the following description of embodiments thereof taken in conjunction with the accompanying drawings.

Fig. 1 is a schematic plan view showing a print head unit according to an embodiment 1 of the present invention;
Fig. 2 is a schematic perspective view showing a monochromatic print head unit 1 used in the embodiment 1;
Fig. 3 is a schematic perspective view showing. an example of print head chip;
Fig. 4A, Fig. 4B and Fig. 4C are schematic views explaining a printing method embodying the invention;
Fig. 5 is a schematic perspective view showing an ink jet printing apparatus used in the embodiment 1 of the present invention;
Fig. 6 is a schematic plan view showing a color print head unit used in an embodiment 2;
Fig. 7 is a schematic perspective view showing the color print head unit used in the embodiment 2;
Fig. 8 is a schematic perspective view showing an example of print head chip;
Fig. 9 is a schematic view for explaining the color printing method of the embodiment 2;
Fig. 10A, 10B, 10C and 10D are schematic views showing an example of printing method at a boundary portion when the print head of the embodiment is used;
Fig. 11A and 11B are schematic views comparing bidirectional printing made by using the print head of the embodiment 2 with a conventional one;
Fig. 12A is a schematic perspective view showing an example of color ink jet printing apparatus used in the embodiment 2;
Fig. 12B is a schematic exploded perspective view showing an example of color ink jet printing apparatus-used in the embodiment 2;
Fig. 13 is a schematic enlarged exploded perspective view showing a carriage portion of the color ink jet printing apparatus used in the embodiment 2;
Fig. 14 is a schematic plan view showing a color print head unit used in an embodiment 3;
Fig. 15 is a schematic exploded perspective view showing the color print head unit used in the embodiment 3;
Fig. 16 is a schematic plan view showing a color print head unit used in an embodiment 4;
Fig. 17 is a schematic perspective view showing the color print head unit used in the embodiment 4;
Fig. 18A and Fig. 18B are schematic views comparing bidirectional printing made using the print head of the embodiment 4 with a conventional one;
Fig. 19 is a schematic plan view showing a color print head unit used in an embodiment 5;
Fig. 20A is a schematic view showing the structure of the print head of the embodiment 5;
Fig. 20B is a schematic view showing the structure of the print head of the embodiment 5;
Fig. 20C is a schematic view showing the structure of the print head of the embodiment 5;
Fig. 21 is a schematic view showing control of HB of the print head of the embodiment 5;
Fig. 22 is a schematic view showing an example of control signal of the print head of the embodiment 5;
Fig. 23 is a schematic perspective view of a color print head used in the embodiment 5;
Fig. 24 is a schematic view showing an example of color printing method of the embodiment 5;
Fig. 25 is a schematic view showing an example of color printing method of the embodiment 5;

Fig. 26 is a schematic plan view showing the color print head used in the embodiment 5;
Fig. 27 is a schematic perspective view of a color print head used in an embodiment 6;
Fig. 28 is a schematic view showing an example of integral type nozzle structure of another embodiment;
Fig. 29 is a schematic view showing an example of integral type nozzle structure of another embodiment;
Fig. 30 is a schematic view showing an example of integral type nozzle structure of another embodiment;
Fig. 31 is a schematic view showing an example of integral type nozzle structure of another embodiment;
Fig. 32A, Fig. 32B and Fig. 32C are schematic views showing examples of separate type nozzle structure of another embodiment;
Fig. 33A, Fig. 33B and Fig. 33C are schematic views showing examples of separate type nozzle structure of another embodiment;
Fig. 34A, Fig. 34B, Fig. 34C and Fig. 34D are schematic views showing examples of separate type nozzle structure of another embodiment;
Fig. 35 is a block diagram showing an example of information processing system using the ink jet printing apparatus of the above embodiments;
Fig. 36 is a schematic perspective view of the above system;
Fig. 37 is a schematic perspective view showing another example of the above system.

[0053] Preferred embodiments of the present invention will now be described in detail with reference to the drawings.

(Embodiment 1)

[0054]

Monochromatic head unit (Bk + S + Bk)
Achieving both Bk high-speed printing and high-speed printing of print improving liquid

(Head structure)

[0055] The structure of an ink jet head according to an embodiment of the present invention will be described.

[0056] Fig. 1 shows the structure of a monochromatic head unit 2000 used in the present embodiment. The head unit comprises a Bk1 chip 2001 for black ink, an S chip for a print improving liquid, and a Bk2 chip 2003 for black ink. These chips are inclined ($\tan\theta = 1/160$) relative to a frame 2004 so that they can be corrected according to the drive timing, and the pitch between the individual chips is set to 1/2 inch. The chips are the same for Bk1/S/Bk2, and the discharge characteristics are shown below.

<Bk1/S/Bk2>
(Discharge characteristics)
Number of nozzles: 160 (number of divided blocks: 16 blocks sequentially driven)
Reliquid: 360 dpi
Drive frequency: 8.0 (kHz)
Discharge amount: Vd = 80 ± 4 (pl/dot)
Discharge speed: 15 ± 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 5.5 (μs)
Release time per block: Tb = 7.5 (μs)

[0057] Fig. 2 is a perspective view of an ink jet cartridge (head unit and inktank). The head unit 2000 and a tank 2010 are detachably provided. When the ink is exhausted, a remaining ink detection mechanism (not shown) prompts the user to replace it.

[0058] The head unit 2000 comprises the Bk1 chip 2001, the S chip 2002, and the Bk2 chip 2003, which are incorporated in the frame 2004. As shown in Fig. 3, each of the head chips 2001, 2002, and 2003 is stuck with a heater board (HB) (not shown) on the Al base plate 2020, a molded polysulfone (PSF) grooved top plate 2022 is placed on top, sealed with a sealing agent (not shown), and the grooved top plate 2022 is mounted to the base plate 2020. These chips are provided with a chip tank 2024 having a mesh filter 2025, and with a printed circuit board (PCB) 2026 for connecting a signal line to a flexible cable of the main unit, and the PCB 2026 is provided with a signal line terminal 2027. The mesh filter 2025 of each chip tank 2024 is protruded from the frame, as shown in Fig. 2, and the individual mesh filters are indicated as 2025-1, 2025-2, and 2025-3.

[0059] The tank 2010 connected to the head unit 2000, as shown in Fig. 2, is divided into a plurality of parts, one is a room 2011 which incorporates a sponge, and another is a room 2012 which incorporates a liquid ink, as is. The room 2011 has a buffer room communicating with the atmosphere, which is filled with air rather than the sponge. Further, the liquid ink incorporated in the ink storage room 2012 is hereinafter referred to as "a raw ink". In the single tank 2010, two types of liquids, that is, a black ink 2014 and the print improving liquid 2015 can be integrally incorporated. The black ink 2014 is incorporated at both sides of the tank, symmetrically about the tank center, and the print improving liquid 2015 is incorporated at the tank center. The tank 2010 has three ink feed ports 2016-1, 2016-2, and 2016-3 communicating with the room 2011 containing the sponge, and each feed port 2016-1, 2, 3 is inserted with a mesh filter 2025-1, 2, 3. Therefore, the filter 2025-1, 2, 3 of the head 2000 is inserted from the feed port 2016-1, 2, 3, the chip is contacted close to the sponge portion of the tank 2010, and sequentially or simultaneously suctioned by main unit recovery means (not shown), thereby feeding the individual inks.

(Print mode)

[0060] Print mode with the head structure of the present embodiment will be described.

[0061] There are basically the following three print modes, which are selectable according to the image quality and print speed required by the user.

1. Fast mode: 1-pass bidirectional 360 × 360 dpi (with/without print improving liquid)
2. Normal mode: 2-pass bidirectional 360 × 360 dpi (with/without print improving liquid)
3. High quality mode: 4-pass unidirectional 720 × 360 dpi (with/without print improving liquid).

[0062] While the print mode can be selected by a printer driver incorporated in the host computer (not shown), it can also be selected by a printer select switch (SW) (not shown).

(Fast mode: without print improving liquid)

[0063] When the print improving liquid is not used, print is made in 1-pass bidirectional mode using both of the two Bk chips 2001 and 2003. Print uses all 160 nozzles of Bk1 and Bk3. The carriage is driven at a high speed with a drive frequency 16 (kHz)/360 dpi/about 1129 (mm/s), twice the head drive frequency of 8 (kHz). Discharge is made from the heads with timing shifted by 1 dot by so that the image is interpolated on the medium to be printed. Using this method, an image of 360 dpi can be printed at an ultra-high speed. In the present embodiment, print is made at an ultra-high speed using the 2 heads, however, alternatively, a mode for making print using normal 1 head may be provided according to the load of the power supply or the motor of the main unit.

(Fast mode: with print improving liquid)

[0064] An example of printing method using the print improving liquid in the present embodiment will be described.

[0065] When 1-pass bidirectional printing is made using the head structure of the present embodiment, depending on the scanning direction of the print head unit, one of the two Bk chips 2001 and 2003 is selected so that the print improving liquid can be printed always before or after. Printing is made using all of the 160 nozzles of Bk1, 2, and S, with a carriage frequency of 8 (kHz)/360 dpi/about 564 (mm/s). While the carriage is driven at a drive frequency of 8 (kHz), same as the head drive frequency, an image of the print improving liquid and the Bk ink is formed on the medium to be printed. In the present embodiment, the Bk heads are used in alternation between the outward and return way during 1-pass bidirectional printing, so that the print improving liquid is always printed before on the printing medium, and then the Bk ink is printed. In this case, the print improving liquid dot and the Bk dot are discharged and applied so that they are perfectly overlapped with each other to enable high speed printing of a 360 dpi image even when using the print improving liquid.

[0066] This can prevent the occurrence of uneven density (uneven band) caused by a difference in density due to a difference in application order (S → Bk or Bk → S) of the print improving liquid and the ink occurring in 1-pass bidirectional printing with a conventional 2 head structure of one Bk head and one print improving liquid head.

(Normal mode: without print improving liquid)

[0067] When the print improving liquid is not used, print is made in 2-pass bidirectional fine mode (mask pattern is zigzag or reverse zigzag) using both of the two Bk chips 2001 and 2003. In the printing method, using all of 160 nozzles of Bk1 and Bk2, in the first outward scanning, the carriage is drive at a high speed with a drive frequency of 16 (kHz) /360 dpi/about 129 (mm/s). While driving the carriage twice the head drive frequency of 8 (kHz), the individual head is

masked in zigzag or revere zigzag so that the image is interpolated on the medium to be printed. This enables high speed 2-dot fine printing of a 360 dpi image when the print improving liquid is not used. In the present embodiment, though 2 heads are used to achieve high speed fine printing, a fine mode may be provided to print using a normal 1 head according to the load of the power supply or the motor of the main unit. The present embodiment uses a zigzag or reverse zigzag pattern of 1 dot for the mask pattern in fine printing, however, alternatively, a conventional method may be used which is optimum for the printing medium, image quality, and ink, such as a plurality of dots, or a deformed pattern with vertical and horizontal lengths varied.

(Normal mode: with print improving liquid)

[0068] An example of printing method when the print improving liquid is used in the present embodiment will be described below.

[0069] When 2-pass bidirectional printing is made using the head structure of the present embodiment, depending on the scanning direction of the print head unit, one of the two Bk chips 2001 and 2003 is selected so that the print improving liquid can be printed always before or after. When printing the first pass in the outward direction, using 80 nozzles at the lower half of 160 nozzles of Bk1 and Bk2. the carriage is driven with a drive frequency of 8 (kHz)/360 dpi/about 564 (mm/s). While the carriage is driven with the same drive frequency as that of the head of 8 (kHz), an image of the print improving liquid (S) and Bk ink (Bk2) is formed on the printing medium. When printing the second pass in the return direction, after the printing medium is fed by 80 nozzles, using all 160 nozzles of Bk1 and Bk2, the carriage is driven with a drive frequency of 8 (kHz)/about 564 (mm/s) and the head is driven with the same drive frequency of 8 (kHz) to form an image of the print improving liquid (S) and Bk ink (Bk1) on the printing medium. After the third pass, printing is made while feeding the paper similarly by 80 nozzles. In this case, in the present embodiment, the Bk heads are used in alternation in the outward and return ways during 2-pass bidirectional printing, so that the print improving liquid (S) is printed on the printing medium always before the Bk ink is printed. In this case, the print improving liquid dot and the Bk dot are discharged and applied so that they are perfectly overlapped with each other to enable high speed printing of a 360 dpi image even when using the print improving liquid.

[0070] This can prevent the occurrence of uneven density (uneven band) caused by a difference in density due to a difference in application order (S $\rightarrow$ Bk or Bk $\rightarrow$ S) of the print improving liquid and the ink occurring in 2-pass bidirectional printing with a conventional 2-head structure of one Bk head and one print improving liquid head.

(High quality mode: without print improving liquid)

[0071] When the print improving liquid is not used, print is made in 4-pass unidirectional mode using both of the two Bk chips. In the printing method, using 40 nozzles, that is, a quarter of 160 nozzles of Bk1 and Bk2 for the first pass, the carriage is driven at a high speed with a drive frequency of 16 (kHz)/720 dpi/about 564 (mm/s) during printing. While driving the carriage at twice the head drive frequency of 8 (kHz), the heads are caused to discharge while developing the print data by a data development unit (not shown) so that the heads are interpolated with each other during 4-pass printing on the medium to be printed. This enables high speed printing of a 720 dpi image when the print improving liquid is not used. When printing the second pass, after the printing medium is fed by 40 nozzles, printing is similarly made while developing the image using all of 160 nozzles of Bk1 and Bk2. After the third pass, paper is similarly fed by 40 nozzles each to achieve printing. In this case, the drive pulse width of Bk1 and Bk2 is narrowed to adjust the discharge amount according to the 720 dpi image, reducing the discharge amount from 80 pl to 40 pl. Further, during the back-scanning, carriage is driven at an ultra-high speed with a drive frequency of 16 (kHz)/360 dpi/about 1128 (mm/s) to return the carriage, and during this period, paper feed 40 nozzles is completed. In the present embodiment, high speed printing is achieved using two heads, however, alternatively, a mode for making print using normal 1 head may be provided according to the load of the power supply or the motor of the main unit.

(High quality mode: with print improving liquid)

[0072] An example of printing method when the print improving liquid is used in the present embodiment will be described below.

[0073] When 4-pass bidirectional printing is made using the head structure of the present embodiment, depending on the scanning direction of the print head unit, one of the two Bk chips is selected so that the print improving liquid can be printed always before or after. When printing in the outward direction of the first pass, using 40 nozzles of the lower quarter of 160 nozzles of Bk1 and Bk2, the carriage is driven with a drive frequency of 8 (kHz)/720 dpi/about 282 (mm/s). While driving the carriage with the same drive frequency as the head drive frequency of 8 (kHz), an image of the print improving liquid (S) and the Bk ink (Bk2) is formed on the medium to be printed. When printing in the return direction of the second pass, after the printing medium is fed by 40 nozzles, using 80 nozzles at the lower half of Bk1,

2, the carriage is driven with a drive frequency of 8 (kHz)/about 282 (mm/s), and while driving the head with the same drive frequency of 8 (kHz), an image of the print improving liquid (S) and the Bk ink (Bk1) is formed on the medium to be printed. After the third pass, paper is similarly fed by 40 nozzles each to achieve printing. In the present embodiment, the Bk heads are used in alternation in the outward and return ways during 2-pass bidirectional printing, so that the print improving liquid (S) is printed on the printing medium always before the Bk ink is printed. In this case, the print improving liquid dot and the Bk dot are discharged and applied so that they are perfectly overlapped with each other to enable high speed printing of a 720 dpi image even when using the print improving liquid.

[0074] This can prevent the occurrence of uneven density (uneven band) caused by a difference in density due to a difference in application order (S $\rightarrow$ Bk or Bk $\rightarrow$ S) of the print improving liquid and the ink occurring in 4-pass bidirectional printing with a conventional 2-head structure of one Bk head and one print improving liquid head. The present embodiment uses a zigzag or reverse zigzag pattern of 1 dot for the mask pattern in fine printing, however, alternatively, a conventional method may be used which is optimum for the printing medium, image quality, and ink, such as a plurality of dots, or a deformed pattern with vertical and horizontal lengths varied.

[0075] Fig. 4 shows a case where the print improving liquid is applied before. The numeral 302 indicates a printing medium, 3031 indicates an outward direction area where printing is made when the carriage scanning direction is from the left to right (outward direction) on the printing medium, and 3032 indicates a return direction area where printing is made when the carriage scanning direction is reverse from the right to left (return direction) on the printing medium.

[0076] In the present embodiment, for 1-pass bidirectional printing, the outward direction area 3031 and the return direction area have 360 dpi with a width of 160 picture elements. In the print area 3031, printing is made using the print improving liquid chip 2002 and the Bk chip 2001. Similarly, in the print area 3032, printing is made using the print improving liquid chip 2002 and the Bk chip 2003 so that the print improving liquid can be applied always before the Bk ink in both the outward and return directions to achieve printing without uneven density. Fig. 4 shows 1-pass high-speed printing mode as bidirectional printing. For multi-pass printing, by selectively using the chips for picture elements for printing in the outward direction and picture elements for printing in the return direction, the application order of the print improving liquid and the ink can be always the same, and printing is possible while reducing the operation frequency of the print head and preventing an increase in temperature, thereby forming a uniform image due to the above described principle.

[0077] In this case, in order that the nozzle used of the print head are not fixed, it is preferable to change the nozzles used (mask pattern) of the individual chips of Bk1/2 at every page or scanning. This can increase the service life of the head and reduce uneven density (variation in discharge) due to operation frequency of the nozzles.

[0078] As described above, with the present embodiment, Bk can be printed at a high speed, when the print improving liquid is used, water resistance and improved letter quality (improved sharpness/line density/feathering) can be obtained, and uneven density when printing a monochromatic image at a high speed can be improved.

(Description of the apparatus)

[0079] An ink jet printing apparatus equipped with the above monochromatic head unit will be briefly described.

[0080] Fig. 5 is a schematic perspective view of an ink jet printing apparatus IJRA according to an embodiment. Referring to the Figure, a carriage HC engaged with a spiral structure 5004 of a lead screw 5005 rotating through drive force transmission gears 5011 and 5009 according to the forward and reverse rotation of a drive motor 5013 has a pin (not shown), and is reciprocally moved in directions of arrows a and b. The carriage HC is provided thereon with an ink jet head unit 2001. The numeral 5002 indicates a paper holding plate, which presses paper against a platen 5000 over the moving direction of the carriage. The numerals 5007 and 5008 indicate home position detection means for selecting the rotational direction of the motor 5013, the numeral 5016 indicates a member for supporting a cap member 5022 for capping the front surface of the print head, the numeral 5015 is suction means for sucking the inside the cap, which makes suction recovery of the print head through a cap opening 5023. The cap member 5022 and the support member 5016 are provided individually according to the above three head chips, and the cap opening 2023 and the suction means 5016 are also provided according to the individual chips. In this case, the sucked print improving liquid S and the Bk ink are carried such that they are not mixed up with each other, and separately stored in waste ink reservoirs (not shown). The numeral 5017 indicates a cleaning blade, and those for colored ink and for the print improving liquid are separately provided. Further, the numeral 5019 indicates members for moving the blade in the front and rear direction, and these are supported on the main unit support plate 5018. The blades may be constructed so that the print improving liquid and the colored ink are not contacted with each other, and the conventional method known in the art can be used. These capping, cleaning, and suction recovery actions are arranged so that a desired treatment is made as necessary at the corresponding position by a selecting action of the lead screw 5005 and a clutch (not shown).

(Embodiment 2)

[0081] Color head unit (Bk + S + CMY)

(Head structure)

[0082] Fig. 6 shows the structure of a color head unit 2100 used in the present embodiment . The head unit comprises a Bk chip 2101, an S chip 2102 (for print improving liquid), and a CMY color integral chip 2103. The individual chips are inclined relative to a frame 2104 so that they can be corrected for the drive timing, and the pitch between the individual chips is set to 1/2 inch. In this case, only the pitch between the S2102 and CMY 2103 is set to 1 inch. This is for common use of the ink tank 2010 used in the embodiment 1. The same Bk chip (discharge amount Vd = 80 pl) as in the embodiment 1 is used. Discharge characteristics of S and CMY are shown below.

(Discharge characteristics of S)
Number of nozzles: 160 (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 (kHz)
Discharge amount: Vd = 40 $\pm$ 4 (pl/dot)
Discharge speed: 12 $\pm$ 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 4.5 (μs)
Release time per block: Tb = 7.5 (μs)

(Discharge characteristics of CMY)

[0083]

Number of nozzles: corresponding to 160 nozzles, 48 nozzles for each color (48 $\times$ 3)/sealing between colors 8 nozzles (8 $\times$ 2) (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 (kHz)
Discharge amount: Vd = 40 $\pm$ 4 (pl/dot)
Discharge speed: 12 $\pm$ 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 4.5 (μs)
Release time per block: Tb = 7.5 (μs)

[0084] Fig. 7 is a perspective view of a color ink jet cartridge (head unit and tank). The head unit 2100, a tank 2110-1 which is the same as the tank in the embodiment 1, and tanks 2100-2C, 2M, 2Y (color ink tanks) detachably structured. When an ink is exhausted, a remaining ink detection mechanism (not shown) prompts the user to replace it through the main unit for each color. The head chips 2101 and 2102, as shown in Fig. 3, are the same as those described in the embodiment 1. The head chip 2103 is able to print three color inks (C, M, Y) by a single chip, in which, as shown in Fig. 8, a heater board (not shown) is stuck to the A1 base plate 2020, a grooved top plate 2122 separated into three liquid chambers by a single polysulfone (PSF) is placed on top, sealed by a sealant, retained with a retaining spring (not shown), and a chip tank 2124, which can independently supply three color inks, is mounted. The grooved top plate 2122 is provided with partitions between colors corresponding to 8 nozzles.

[0085] The tank 2110-1 (for Bk + S) is the same as in the embodiment 1 and detailed description thereof is omitted. However, because there are three ink supply ports for two chips, the right side Bk2 ink supply port remains as an extra, from which ink leakage or vapor tends to generate. To prevent this, the head unit 2100 is provided with a cover 2105 for closing the hole. In the present embodiment, the color 2105 is attached to the head unit 2100 to prevent vaporization of ink, however, alternatively, the tank side and the filter side may be structured in which a communication hole is provided only at the portion contacting with the filter unit when the tank is mounted so that the ink is supplied through the hole.

[0086] The tanks 2110-2C, 2M, 2Y are the same in structure, and divided into a plurality of chambers; one is a chamber 2111 where the sponge is incorporated, and another is a chamber 2112 where the raw ink is incorporated. The chamber 2111 has a buffer chamber. One color uses a tank 2110-2. To supply each ink, the sponge portion of the

tank 2110-1 and the tanks 2110-2C, 2M, or 2Y is contacted close to the filter 2124-Bk, and 2124-C, M, Y of the head 2100, and sucked sequentially or simultaneously by the main unit recovery means (not shown).

(Print mode)

[0087] Color print mode with the head structure of the present embodiment will be described. Since the Bk printing method is the same as prior art, it will be briefly described here.

[0088] There are basically the following three print modes, which are selectable according to the image quality and print speed required by the user.

1. Fast mode: 1-pass bidirectional 360 × 360 dpi (with/without print improving liquid)
2. Normal mode: 2-pass bidirectional 360 × 360 dpi (with/without print improving liquid)
3. High quality mode: 4-pass uni/bidirectional 720 × 360 dpi (with/without print improving liquid).

[0089] While the print mode can be selected by a printer driver incorporated in the host computer (not shown), it can also be selected by a printer select SW (not shown).

[0090] For simplicity, here the color printing method using the above head structure, and the printing method of the print improving liquid at the boundary portion for preventing white fogging occurring at the boundary between colored ink portion and Bk ink portion will be mainly described here.

(Bk print mode)

[0091] With the head of the present embodiment, when the printed matter has an image of Bk ink only, there are provided

[0092] High speed print mode (print mode - Bk1) in which the print improving liquid is printed in alternation in the pre-feed condition and the follow feed condition in bidirectional printing mode using 160 nozzles each of the Bk chip 2101 and the print improving liquid chip 2102:

[0093] However, when an uneven band is generated due to penetration condition of pre-feed / follow feed,

[0094] A print mode (print mode - Bk2) in which fine printing is made with the mask applied for every scanning while feeding paper by 80 nozzles in 160 nozzles each of the Bk chip 2101 and the print improving liquid chip 2102, wherein printing is made in bidirectional printing while making mask treatment so that Bk and the print improving liquid are individually applied in about halves in area for the pre-feed condition and the follow feed condition, and the difference in density between the pre-feed condition and the follow feed condition is distributed to be invisible to human eyes as an average density, thereby preventing occurrence of uneven density and enabling high speed printing without uneven density in bidirectional printing, and

[0095] A print mode (print mode - Bk3) in which the print improving liquid is always fixed to the pre-feed condition or the follow feed condition by making printing in unidirectional printing using individual 160 nozzles of the Bk chip 2101 and the print improving liquid chip 2102 (conventional printing method) thereby achieving positive printing, though being low in speed.

<Color print mode>

[0096] On the other hand, when the printed matter has a color image, the Bk chip 2101 and the print improving liquid chip 2102 are printed using only (cyan side) 48 nozzles which is first printed among 160 nozzles, according to the number of nozzles of one color (C) of the color chip 2103. An example of color image formation method is shown below.

[0097] During the outward direction printing of the first scan, using only 48 nozzles of 160 nozzles of Bk, the first line is printed using 48 nozzles of the color integral type head C. During the return direction printing of the second scan, the first line is printed using 40 nozzles of M. At this moment, Bk and C of the second line are also printed using 48 nozzles. Then, the printing medium is carried by 48 nozzles, during the outward direction printing of the third scan, the first line is printed using 32 nozzles of Y. At this moment, printing is made using 8 nozzles of M of the second line and 48 nozzles of Bk and C of the third line. Further, the printing medium is carried by 48 nozzles, during the return direction printing of the fourth scan, the first line is printed using 16 nozzles of Y. At this moment, printing is made using 8 nozzles of M and 32 nozzles of Y, and 40 nozzles of M of the third line. Thereafter, the image is formed similarly, and in the last line, while making printing in reverse of the above, formation of image is completed.

[0098] As described above, printing is made while completing color print of one line by 4 scans.

[0099] Next, using the present head structure, an example of printing method of the print improving liquid at the boundary in 1-pass bidirectional printing will be described with reference to Fig. 10A. Fig. 10B - Fig. 10D will be described later.

[0100] In the present embodiment, the Bk ink used (HS Ink: High Solid) is one which is low in penetration, high in printing density, and good in sharpness, but slightly inferior in fixing, and the color ink (common for C, M, Y/QS Ink: Quick Set) is one which is high in penetration, with no blotting between colors, and good in fixing, but slightly inferior in feathering. Therefore, blotting or white fogging (ink dye is partly diluted and looks white) tends to occur at the boundary between the Bk ink and color ink depending on a difference in properties between the Bk ink and color ink.

[0101] In the head structure of the present embodiment, the print improving liquid chip 2102 is disposed between the Bk chip 2101 and the color chip 2103. Therefore, in the outward direction printing, the ink and the print improving liquid are applied in the order of C ink → print improving liquid → Bk ink → M → Y ink, when printing the Bk ink, the print improving liquid is already applied to the printing medium, and the color ink and C/K ink do not directly contact at the boundary. If contact, since the color material of C ink reacts with the print improving liquid (insolubilize or coagulate), the print improving liquid on the C ink reacts with the Bk ink (insolubilize or coagulate), and movement of the color material of the Bk ink does not occur, bleeding or white fogging does not generate. Further, in the return direction printing, print is made in the order of Bk ink → print improving liquid → C ink → M ink → Y ink. On the contrary, in the outward direction printing, when printing the color ink, since the print improving liquid is already applied to the printing medium, and the color material of the Bk ink reacts with the print improving liquid (insolubilize or coagulate) at the boundary, there is no problem. If contact, since it is after the color material of the Bk ink reacts with the print improving liquid (insolubilize or coagulate), no movement of the color material of C/Bk ink occurs, and bleeding or white fogging does not generate. Therefore, with the print head structure of the present embodiment, color materials of the Bk ink and color ink do not directly contact at the boundary, and the prior art problems can be eliminated. In printing the print improving liquid at the boundary in the present embodiment, printing is made in dot-on-dot at the Bk side, and in 2-picture element width at the color side.

[0102] The print width of the print improving liquid at the boundary at this moment must be printed at least 1 picture element each for both colored inks in dot-on-dot, preferably, 2 picture elements or more. Further, it is preferable to increase the ink application amount of the print improving liquid for ink of high dye concentration and at the side of ink where penetration is slow. Limitation of printing width and application amount of the print improving liquid, that is, reduction of the amount of print improving liquid by thinning out from the dot-on-dot, types of the ink and printing medium used, printing method (number of buses/bidirectional/unidirectional) may be flexibly determined according to the desired image quality and printing speed. When the amount of the print improving liquid is increased, an increase in running cost and a degradation of print quality due to the occurrence of cockling are generated.

[0103] In general printing media, the application amount to the medium is 16 (nl) per square mm, and 20 (nl) at the maximum. If the level is exceeded, it will lead to head friction / image staining / head malfunction due to the occurrence of cockling of the printing medium, and various troubles may occur such as slow ink penetration, deteriorated fixing, back copying of image and smear.

[0104] In the head structure of the present embodiment, when making bi-directional printing, print is carried out as shown in Fig. 11A and Fig. 11B. In the Figure, for simple understanding of the Bk ink and print improving liquid, an example of 4 nozzle head structure is shown. The numeral 3101 indicates a picture element printed in the outward direction where the ink jet head moved from the left to the right, applied in the order of print improving liquid → ink to the printing medium. Further, the numeral 3102 indicates a picture element printed in the return direction from the right to the left, applied in the order of ink → print improving liquid. In the conventional printing method, the picture element 3101 and the picture element 3102 become bands at every nozzle width in 1-pass bidirectional printing, and an uneven density is conspicuous (Fig. 11A). On the other hand, in the present embodiment, the individual picture elements are arranged in zigzag or reverse zigzag, and the same area must be printed in more than 2 passes, so that while both are mixed microscopically, a macaroscopically uniform image can be formed (Fig. 11B).

(Description of the apparatus)

[0105] The color ink jet printing apparatus equipped with a color ink jet head described above will be briefly described. Fig. 12A is a perspective view of the color ink jet printing apparatus. Fig. 12B is a perspective exploded view of the color ink jet printing apparatus. Further, Fig. 13 is an enlarged view in the vicinity of the carriage of the ink jet printing apparatus.

[0106] A carriage 1006 can be provided thereon with a print head unit 2100 and an ink tank group 2110-1 and. 2110-2 for supplying inks to the print head 2100. The carriage 1006 mainly comprises a carriage base 1201 for putting thereon the print head unit 2100 and the ink tank group 2110, and a head lever 1202 for holding the print head unit 2100 placed thereon. A connector 8022 for receiving a signal or power for drive control of the print head is provided on the top surface of the print head unit 2100. When the print head unit 2100 is mounted on the carriage 1006, the connector 8022 is electrically connected with a connector 6022 provided at the carriage 1006 side. A guide shaft 1004 and a support shaft 1103 for slidably supporting the carriage 1006 are disposed on both side walls of a chassis 1001.

[0107] Driving force for reciprocally moving the carriage 1006 on both shafts in the main scanning direction is supplied

form a carriage motor 1104 through a drive belt 1010. Further, holding and carrying of the medium to be printed such as paper or the like is made by a platen roller and pinch roller (not shown), and the medium to be printed is carried on a platen 1016. At this moment, the nozzle group of individual print chips 2101-2103 of the print head unit 2100 provided on the carriage 1006 are disposed so that the ink is discharged downward, and to oppose parallel to the medium to be printed on the platen 1016.

[0108] In the present embodiment, the recovery unit 1015 is disposed at the home position at the right side of Fig. 12. When the carriage 1006 is at the home position, the individual chips of the print head 2100 and suction/release caps (rubber) 1013-1-3 closely contact to be capped, normally individual suction caps 1013-1 for ink and 1013-2 for print improving liquid and a release cap 1013-3 prevent evaporation of ink in the nozzles of the print chips, an increase in viscosity, and occurrence of sticking, thereby preventing degradation of reliability due to discharge trouble. The print chip 2103 opposing the release cap is moved to the suction cap 1013-1, and then sucked.

[0109] Further, when replacing the ink tank or on discharge trouble, the suction caps 1013-1-3 and the print chips 2101-2103 are closely contacted to generate a negative pressure by a pump unit (not shown), and ink replacement or discharge recovery can be carried out by a suction recovery mechanism. Still further, ink and print improving liquid discharged from the pump are separately recovered into waste ink tanks.

[0110] Yet further, image signals are transmitted from the host (not shown) through I/F and the like, temporarily stored in the print buffer, developed to data according to the nozzles of the head and the print mode, sent to the head driver as drive signals, and discharged from the print head to form an image.

[0111] A control panel 8022 for controlling the print conditions is provided on the top surface of the apparatus.

(Embodiment 3)

[0112]

Color head unit (Bk1 + S + Bk2 + CMY)
Head structure for print improving liquid sandwich condition

(Head structure)

[0113] Fig. 14 shows a color head unit 2200 used in the present embodiment. The head unit comprises a Bk1 chip 2201 (discharge amount: Vd =40 (pl)), an S (print improving liquid) chip 2202 (discharge amount: Vd = 40 (pl)), a Bk chip 2303 (discharge amount: Vd = 40 (pl)), and a CMY integral chip 2204 (discharge amount: Vd = 40 (pl)). The individual chips are inclined relative to a frame 2004 so that they can be corrected according to the drive timing, and the pitch between the individual chips is set to 1/2 inch. Among the individual chips, Bk1/S/Bk2 are the same as those in the embodiment 1, and CMY is the same as in the embodiment 2. However, the heater size and hole diameters are different. The discharge characteristics of Bk and CMY are shown below.

(Discharge characteristics of Bk1/Bk2/S)
Number of nozzles: 160 (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 (kHz)
Discharge amount: Vd = 40 $\pm$ 4 (pl/dot)
Discharge speed: 12 $\pm$ 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 4.5 (μs)
Release time per block: Td = 7.5 (μs)
(Discharge characteristics of CMY)
Number of nozzles: corresponding to 160 nozzles, 48 nozzles for each color (48 $\times$ 3)/sealing between colors 8 nozzles (8 $\times$ 2) (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 (kHz)
Discharge amount: Vd = 40 $\pm$ 4 (pl/dot)
Discharge speed: 12 $\pm$ 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 4.5 (μs)
Release time per block: Td = 7.5 (μs)

[0114] Fig. 15 is a perspective view of a color ink jet cartridge comprising the head unit and tank. The head unit 2200, a tank 2210-1(the same as the tank in the embodiment 1), and color ink tanks 2100-2C, 2M, 2Y are detachably structured. When an ink is exhausted, a remaining ink detection mechanism (not shown) prompts the user to replace it through the main unit for each color. The head chips 2201 and 2202 are the same as those described in the embodiment 1 in Fig. 3. The head chip 2203 is the same as described in embodiment 2 in Fig. 8. The tank 2210-1 (for Bk + S) is the same as described in the embodiments 1, 2 and detailed description thereof is omitted. Further, the tanks 2210-2C, 2M, 2Y are the same as those in the embodiment 2, and detailed description thereof is omitted.

<Print mode>

1) Bk print

[0115] As the printing method of the present embodiment, when discharge amounts of the Bk chips 2201 and 2203 are both set to 40 pl, an image is formed in the order of Bk1 ink (40 pl) → print improving liquid S (40 pl) → Bk ink (40 pl). At this moment, the total amount of Bk ink applied to the picture element is 80 pl, unchanged from the above described printing. This increases the reaction area (contact area is approximately doubled) of the ink and the print improving liquid to obtain a stable effect of the print improving liquid, without changing the total application amount of the ink and print improving liquid, and the application order of the ink and print improving liquid is unchanged between the outward direction and return direction. Therefore, the above-described uneven density due to a difference in application order does not occur even when bidirectional printing is made at a high speed. As a practical printing method, a print mode is added in which the discharge amount of the Bk print mode of embodiment 1 is decreased to a half so that the print improving liquid is always sandwiched between the Bk ink.

2) Color print

[0116] Color print is the same as embodiment 2, and detailed description thereof is omitted.

(Description of the apparatus)

[0117] Since the printing apparatus is the same as in the embodiment 2, description thereof is omitted. However, the head chip Bk2 is provided as an extra, signal/control line (not shown) for the chip is included. In this case, the contact surface of the apparatus is commonly used.

(Embodiment 4)

[0118] Color head unit (Bk + S (1/2) shifted + C + M + Y)

[0119] Only the print improving liquid is shifted by a half pitch to increase the contact area and decrease the consumption of the print improving liquid.

<Head structure>

[0120] Fig. 16 shows the structure of a color head unit 2300 used in the present embodiment. The head unit comprises a Bk chip 2301, a print improving liquid S chip 2302, a C chip 2303, an M chip 2304, and a Y chip 2305. The individual chips are inclined relative to a frame 2104 so that they can be corrected for the drive timing, and the pitch between the individual chips is set to 1/2 inch. However, in this case, only the pitch between the chip S2102 and C 2303 is set to 1 inch for common use of the ink tank 2010 used in the embodiment 1.

[0121] Further, the Bk chip 2301 and the print improving liquid chip 2302 are disposed shifted by an odd number times of 1/2 picture element (about 35 (μm) at 360 dpi in (x, y) directions on the unit. In the head unit described in the present embodiment, the basic spacing of the individual heads in the x direction (main scanning direction of head) is 1/2 inch (width of 180 picture elements at 360 dpi), and with respect to this, only the S chip is disposed shifted by 1/2 picture element. That is, the Bk1 chip and the S chip are disposed shifted by 180.5 picture elements in the x direction, and 0.5 picture element in the y direction (sub-scanning direction of head). Hereinafter this head chip arrangement is conventionally referred to as [half picture element shift], or [1/2 picture element shift]. The effect of the shift will be described later, the contact area of the Bk ink and CMY ink is increased, by shifting the application position of the print improving liquid by a half picture element in (x, y) directions in the image design to increase an apparent AF (area factor). This generates the reaction by applying a required minimum amount of the print improving liquid to reduce the total consumption of the print improving liquid.

[0122] The Bk chip is the same as in the embodiment 1 (80 (pl)), and other S/C/M/Y chips are the same as those in

the embodiment 2 (40 (pl)). The discharge characteristics of the individual chips are as shown below.

(Discharge characteristics of Bk)
Number of nozzles: 160 (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 10.0 (kHz)
Discharge amount: Vd = 80 ± 8 (pl/dot)
Discharge speed: 15 ± 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 5.5 (μs)
Release time per block: Td = 6.0 (μs)

(Discharge characteristics of CMY)
Number of nozzles: corresponding to 160 nozzles, 160 nozzles for each color (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 10.0 (kHz)
Discharge amount: Vd = 40 ± 4 (pl/dot)
Discharge speed: 12 ± 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 4.5 (μs)
Release time per block: Td = 6.0 (μs)

[0123] Fig. 17 is a perspective view of a color ink jet cartridge comprising the head unit and tank. The head unit 2300, a tank 2310-1(the same as the tank in the embodiment 1), and color ink tanks 2100-2C, 2M, 2Y (the same as those in the embodiment 2) are detachably structured. When an ink is exhausted, a remaining ink detection mechanism (not shown) prompts the user to replace it through the main unit for each color. The head chips 2301 and 2302 are the same as those described in the embodiment 1 as shown in Fig. 3. The head chips 2303, 2304, and 2305 are made possible to print three color inks (C, M, Y) by color chips. In this case, only the head chip 2302 is disposed shifted by a half picture element of 360 dpi in (x, y) directions when mounting on a frame 2306 of the head unit 2300.

[0124] The tank 2110-1 (for Bk + S) is the same as in the embodiment 1 and detailed description thereof is omitted. However, because there are three ink supply ports for two chips, the right side Bk2 ink supply port remains as an extra, from which ink leakage or vapor tends to generate. To prevent this, the head unit 2300 is provided with a cover 2307 for closing the hole. The tanks 2310-2C, 2M, 2Y are divided into a plurality of chambers; one is a chamber (including a buffer chamber) for incorporating the sponge, and another is a chamber for incorporating the raw ink. One color uses a tank 2310-2. To supply each ink, the sponge portion of the tank 2310 is contacted close to the filters 2325-Bk, 2124-C, M, Y of the head 2300, and sucked sequentially or simultaneously by the main unit recovery means (not shown).

<Print mode>

Bk/color print mode

[0125] The printing method with the head of the present embodiment will be described. The ink types used in the present embodiment are the same as those used in the embodiment 2. In the head structure of the present embodiment, the individual chips are controlled for printing at the same drive timing so that the print improving liquid is applied always shifted by a half picture element in the (x, y) directions between the Bk ink and the color ink without increasing the load of the head drive control in the printer main unit. Therefore, since the contact area with the individual colored ink is increased at the boundary, occurrence of bleeding or white fogging can be prevented while reducing the consumption of the print improving liquid. Further, a printing method for eliminating an uneven density by a change in hue ((Blue) C → M/M → C, (Green) C → Y/Y → C, (Red) M → Y/Y → M) due to a difference in application order of colors, or an uneven density (S → C/C → S, S → C → M/M → C → S or the like) due to a difference in application order of the print improving liquid during color printing will be described.

[0126] As an example, in addition to an uneven density due to a difference in application order or application time of the print improving liquid and colored inks during the above-described bidirectional printing, an uneven color due to a difference in application order of color inks will be described.

[0127] Fig. 18A and Fig. 18B show an example of bidirectional printing in the present embodiment compared with a prior art example. In Fig. 18A and Fig. 18B, for simple understanding of printing the magenta ink, yellow ink, and the

print improving liquid when forming a red color, the procedure will be shown with reference to a 4-nozzle head structure. The numeral 3301 indicates a picture element which is printed in the outward direction printing when the head unit moves from the left to the right, applied in the order of Y ink → M ink → print improving liquid on the printing medium. Further, the numeral 3302 indicates a picture element which is printed in the return direction printing when the head unit moves from the right to the left, applied in the order of print improving liquid → M ink → Y ink. In the conventional printing method, as shown in Fig. 18A, the picture element 3301 and the picture element 3302 form bands at an interval of nozzle width with remarkable uneven density in 1-pass bidirectional printing. On the other hand, in the present embodiment, as shown in Fig. 18B, the colored inks are printed in zigzag or reverse zigzag so that the individual picture elements are formed as a group of 2 × 2. Formation of 2 × 2 picture elements as a group is a means for preventing a regular bank-like uneven color due to a difference in application order of inks generating in bidirectional printing when an overall print of a neutral tint is made.

[0128] Further, the print improving liquid head, as described above, is disposed shifted by a half picture element relative to each of the colored ink head in the (x, y) directions. Therefore, when printing the print improving liquid at the boundary, even printing of only one picture element of the print improving liquid at the boundary is found to have the same effect as described in the embodiment 2. That is, since the print improving liquid is applied at the boundary shifted by a half picture element in the vertical and longitudinal directions, the apparent contact area is increased, bleeding and white fogging generating at the boundary of Bk and color ink can be prevented even when the amount of the print improving liquid is reduced (corresponding to 1 picture element line).

[0129] Still further, as in the embodiment 2, similarly to the case where those of the reverse application order of colors are microscopically mixed as picture elements of about (2 × 2), those of the reverse application order of the print improving liquid and the colored ink can be printed to form macroscopically an even image by microscopically mixing as picture elements of about (2 × 2).

[0130] In the present embodiment, only the print improving liquid is disposed on the head unit shifted by a half picture element of the reliquid in the main/sub-scanning directions to obtain the above effect, however, it is needless to say that, as to the main scanning direction, the electrical discharge timing may be shifted by a half picture element, and as to the sub-scanning direction, paper may be fed by a half picture element to obtain the same effect.

[0131] Yet further, it is also possible to increase even further the consumption reduction effect of print improving liquid and image quality improving effect by combining the half picture element shift of the print improving liquid with the thinning/emphasis treatment.

(Embodiment 5)

[0132] Color head unit 4 (Bk1 + S + Bk2 +C + M + Y)

[0133] This embodiment considers combination with the printing method of the print improving liquid.

<Head structure>

[0134] Fig. 19 shows the structure of a color head unit 2400 used in the present embodiment. The unit comprises a Bk chip 2401, a print improving liquid S chip 2402, a Bk2 chip 2403, a C chip 2404, an M chip 2405, and a Y chip 2406. The individual chips are inclined relative to a frame 2307 so that they can be corrected for the drive timing, and the pitch between the individual chips is set to 1/2 inch. In this case, the Bk2 chip is disposed shifted by an odd number times of half picture element (about 35 μm) of 360 dpi relative to the Bk1 chip and other chips in the X, Y directions. In the head unit described in the present embodiment, the basic spacing of the individual chips in the x direction, which is the main scanning direction of the head, is 1/2 inch, that is, 180 picture element width of 360 dpi. In other words, the Bk1 chip relative to the Bk2 chip is disposed shifted by 360.5 picture element in the x direction and 0.5 picture element in the y direction. This is to achieve 720 dpi printing by 1 pass since the Bk1 and Bk2 are shifted by a half picture element.

[0135] Further, to form an optimum image of 360/720 dpi at a high speed, two heaters are disposed in parallel in 1 nozzle, and the individual heaters are independently driven, so that Bk1/Bk2 can discharge three kinds of discharge amounts of 70/45/25 (pl) by a single chip, and S/C/M/Y can discharge three kinds of 40/25/15 (pl) by a single chip. The nozzle structure and the heater structure are as shown in Fig. 20A to Fig. 20C. That is, two types of heaters, large and small, 103A and 103B are provided in juxtaposition in a liquid passage 102 communicating with the individual nozzles 101.

[0136] In driving the individual heaters 103A and 103B, selection of high/medium/low discharge amounts is possible by transmitting signal waveforms shown in Fig. 22 to the individual signal lines of the heater boards H, B shown in Fig. 21. Specifically, block is selected by Block - Enable 0 -2, and the large or small heater is selected by Heat - Enable 1 - 2. The actual drive pulse waveform is given by Heat - data.

[0137] Discharge principle of large/small dots in the present embodiment has no direct relation to the present invention, and detailed description thereof is omitted. Discharge of large/small dots may be achieved by other means such

as pulse width modulation. In the present invention, relationship between large/small colored ink dots and large/small print improving liquid dots will be described in detail.

[0138] The discharge characteristics of the individual chips are as shown below.

(Discharge characteristics of Bk1/Bk2)
Number of nozzles: 160 (number of divided blocks: 16 blocks)
Reliquid: for both 360/720 (interlace 2-pass printing) dpi
Drive frequency: 10.0 (kHz)
Discharge amount: Vd = 70 ± 4/45 ± 2.5/25 ± 1.5 (pl/dot)
Discharge speed: v = 16 ± 0.5/13 ± 0.5/10 ± 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 5.5 (μs)
Release time per block: Td = 6.0 (μs)

(Discharge characteristics of S/C/M/Y)
Number of nozzles: 160 nozzles, (number of divided blocks: 16 blocks)
Reliquid: for both 360/720 (interlace 2-pass printing) dpi
Drive frequency: 10.0 (kHz)
Discharge amount: Vd = 40 ± 4/25 ± 2.5/15 ± 1.5 (pl/dot)
Discharge speed: v = 14 ± 0.5/10 ± 0.5/8 ± 0.5 (m/s)
(Drive condition)
Drive voltage: Vop = 24.0 (V)
Drive pulse width: Pw = 4.0 (μs)
Release time per block: Td = 6.0 (μs)

[0139] Fig. 23 is a perspective view of a color ink jet cartridge comprising the head unit and tank. The head unit 2400, a tank 2410-1(the same as the tank in the embodiment 1), and color ink tanks 2410-2C, 2M, 2Y are detachably structured. When an ink is exhausted, a remaining ink detection mechanism (not shown) prompts the user to replace it through the main unit for each color. The head chips 2401 and 2403 are the same as the Bk chip 2101 described in the embodiment 1 as shown Fig. 3 except for the heater board. The head chips 2402, 2404 to 2406, as shown in Fig. 3, are the same as the S chip 2102 described in embodiment 1 except for the heater board.

[0140] The tank 2410-1 (for Bk1 + S + Bk2) is the same as described in the embodiment 1, and detailed description thereof is omitted. Further, the tanks 2410-1, 2C, 2M, 2Y are the same as those in the embodiment 2, and detailed description thereof is omitted. To supply each ink, the sponge portion of the tanks 2410-1, 2C, 2M, 2Y is contacted close to the filters 2425-Bk1, S, Bk2, C, M, Y of the head 2400, and sucked sequentially or simultaneously by the main unit recovery means (not shown).

<Print mode>

[0141] The print mode in the present embodiment and an example of actual print dot image are shown in Fig. 24 and Fig. 25.

1) Bk mode

[0142]

1. Fast mode: 1-pass bidirectional 360 × 360 dpi (with/without print improving liquid)
2. Normal mode: 2-pass bidirectional 720 × 720 dpi (diagonal)/45 pl (with/without print improving liquid)
3. High quality mode: 4-pass unidirectional 720 × 720 dpi (full address)/25 pl (with/without print improving liquid).

2) Color mode

[0143]

1. Fast mode: 1-pass bidirectional 360 × 360 dpi/40 pl (with/without print improving liquid)
2. Normal mode: 2-pass bidirectional 720 × 720 dpi (diagonal)/25 pl (with/without print improving liquid)
3. High quality mode: 4-pass unidirectional 720 × 720 dpi (full address)/15 pl (with/without print improving liquid).

[0144] In the present embodiment, first, (1) for using the print improving liquid in Bk printing, when the print improving liquid dot diameter is smaller than the Bk dot diameter, and (2) when the print improving liquid dot diameter is larger than the Bk dot diameter will be described.

(1) When the print improving liquid dot diameter is smaller than the Bk dot diameter

[0145] In this case, when printing the print improving liquid in a Bk overall printed portion, normally the Bk ink and an equivalent amount of the print improving liquid are applied in dot-on-dot, and thinning of the print improving liquid is made as necessary. However, in the present embodiment, to reduce the time required for thinning and cost for the hardware processing, instead of printing the print improving liquid and the Bk ink at the same position in dot-on-dot, the discharge amount of the print improving liquid is decreased to be smaller than the Bk ink to obtain the same effect of thinning. This improves the printing speed (processing speed) and reduces the consumption of the print improving liquid to reduce the running cost and the application amount of the ink, thereby achieving cost reduction and stabilization of the image quality.

(2) When the print improving liquid dot diameter is larger than the Bk dot diameter

[0146] In this case, when printing the print improving liquid at the Bk boundary, normally the print improving liquid in equivalent amount to the Bk ink is applied in dot-on-dot, and the print width of the print improving liquid at the boundary is increased as necessary, in particular, for reducing feathering and improving the line density of letters on plain paper and improving the sharpness. However, in the present embodiment, to reduce the time required for boundary processing and cost for hardware processing, the print improving liquid is also printed at the same position of the Bk ink in dot-on-dot to increase the discharge amount of the print improving liquid to more than the Bk ink, thereby obtaining the same effect as the boundary processing (print width increasing processing). This improves the printing speed (processing speed) and reduces the consumption of the print improving liquid to reduce the running cost and partial application amount of the ink, thereby achieving cost reduction and stabilization of the image quality.

[0147] The above described is just an example, and it is needless to say that the printing method of Bk can be improved by another method to reduce the discharge amount of the print improving liquid.

[0148] Further, in the present embodiment, (1) in using the print improving liquid in color printing, when the discharge amount of the print improving liquid is varied between the boundary and other positions, and (2) as a printing method to reduce a difference in hue due to the application order of ink, a case where the discharge amount of the print improving liquid is varied according to the application order of ink, will be described.

(1) Processing of color boundary and other images

[0149] In this case, when printing the print improving liquid at the boundary of Bk and color ink and the individual colored ink portions, normally the print improving liquid in an equivalent amount to the Bk/color ink is printed at the boundary in dot-on-dot, while thinning is made in other colored ink portions. In particular, to reduce bleeding or white fogging between Bk and color in a graph on plain paper, the printing width of the print improving liquid at the boundary is increased, or thinning is made to reduce the consumption in other portions. However, in the present embodiment, to reduce the time required to boundary processing and the cost for hardware processing and reduce the consumption of the print improving liquid, the discharge amount of he print improving liquid is increased at the boundary portion of the Bk ink and the color ink, and reduced in other portions. Therefore, printing is only made at the same position in dot-on-dot to increase the discharge amount of the print improving liquid to more than colored inks to obtain the thinning effect in other portions while obtaining the same effect as the boundary processing (print width increase processing). This improves the printing speed (processing speed) and reduces the consumption of the print improving liquid to reduce the running cost and partial application amount of the ink, thereby achieving cost reduction and stabilization of the image quality.

(2) Measure for hue variation due to application order of inks

[0150] This is for a case where the print improving liquid is printed according to the application order of color inks, normally when bidirectional printing is made to form a secondary color, there occur uneven density (uneven color) due to hue variation in color ((Blue) C $\rightarrow$ M / M $\rightarrow$ C, (Green) C $\rightarrow$ Y / Y $\rightarrow$ C, (Red) M $\rightarrow$ Y / Y $\rightarrow$ M) caused by reversed application order, and uneven density due to application order of the print improving liquid in color printing (S $\rightarrow$ C / C $\rightarrow$ S, S $\rightarrow$ C $\rightarrow$ M / H $\rightarrow$ C $\rightarrow$ S and the like). This occurs because the print improving liquid in an equivalent amount to the colored ink is applied in dot-on-dot. In particular, in 1-pass high-speed color printing on plain paper, to reduce the time required for mask processing and cost for hardware processing when printing in a plurality of passes by the

above-described mask pattern of 7-color print such as graphs, the discharge amount of the print improving liquid for an ink color to be emphasized, and the discharge amount of the print improving liquid is decreased when not to be emphasized. Therefore, even if the application order is reversed in bidirectional printing in the same position, only by changing the discharge amount of the print improving liquid when printing in dot-on-dot, the same effect as the mask processing of the print improving liquid and the application order, thereby reducing the consumption of the print improving liquid. This improves the printing speed (processing speed) and reduces the consumption of the print improving liquid to reduce the running cost and partial application amount of the ink, thereby achieving cost reduction and stabilization of the image quality.

[0151] As described in the present embodiment, it has been found that by varying the discharge amount of the print improving liquid as necessary, the effect of the print improving liquid can be increased, and an effect which could not be obtained in the past can be obtained. Here, as described above, an example of printing condition when changing the discharge amount at the boundary or shifting the application position is shown in Figs. 10B to Fig. 10D. Fig. 10C shows a case where the application position of the print improving liquid is shifted at the boundary, and Fig. 10D shows a case where the reliquid of the print improving liquid at the boundary is improved and the application position is shifted.

(Embodiment 6)

[0152] Color head unit 6 (2 units of Bk1 + S + Bk2, and C + M + Y)

[0153] Reduction of discharge amount of print improving liquid (thinning effect of simple high-speed processing) and sandwich effect

[0154] Fig. 26 shows the structure of a 2-unit system of color head units 2500-1 and 2500-2 used in the present embodiment. The unit comprises a unit integrating a Bk1 chip 25001 (discharge amount: Vd = 40 pl), a print improving liquid chip 25002 (discharge amount: Vd = 20 pl), and a Bk2 chip 2503 (discharge amount: Vd = 40 pl), a C chip 2504, an M chip 2505, and a Y chip 2506. The individual chips are inclined by the drive timing, and the pitch between the individual chips is set to 1/2 inch, and the pitch between units is set to 1 inch. The Bk1/Bk2 chips are the same as those used in the embodiment 1, and the CMY chip is the same as used in the embodiment 2. However, the heater size and hole diameters are different. S has a half of the discharge amount of Bk1/Bk2. The discharge characteristics of Bk1/Bk2/S and C/M/Y are shown below.

(Discharge characteristics of Bk1/Bk2)
Number of nozzles: 160 (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 kHz
Discharge amount: Vd = 40 $\pm$ 4 pl/dot
Discharge speed: 12 $\pm$ 0.5 m/s
(Drive condition)
Drive voltage: Vop = 24.0 V
Drive pulse width: Pw = 4.5 μs

(Discharge characteristics of S)
Number of nozzles: 160 nozzles (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 kHz
Discharge amount: Vd = 20 $\pm$ 2 pl/dot
Discharge speed: 12 $\pm$ 0.5 m/s
(Drive condition)
Drive voltage: Vop = 24.0 V
Drive pulse width: Pw = 3.5 μs
Release time per block: Tb = 7.5 μs

(Discharge characteristics of CMY)
Number of nozzles: corresponding to 160 nozzles, 48 nozzles for each color (48 $\times$ 3)/sealing between colors 8 nozzles (8 $\times$ 2) (number of divided blocks: 16 blocks)
Reliquid: 360 dpi
Drive frequency: 8.0 kHz
Discharge amount: Vd = 20 $\pm$ 2 pl/dot
Discharge speed: 12 $\pm$ 0.5 m/s
(Drive condition)

Drive voltage: Vop = 24.0 V
Drive pulse width: Pw = 4.5 μs
Release time per block: Tb = 7.5 μs

[0155] Fig. 27 is a perspective view of a color head unit comprising the head and tank. A head 2500-1, a head 2500-2, and a tank 2510-1(the same as the tank in the embodiment 1)/color ink tanks 2510-2C, M, Y are detachably structured. When an ink is exhausted, a remaining ink detection mechanism (not shown) prompts the user to replace it through the main unit for each color. The head chips 2501/2503 to 6 are the same as those described in the embodiment 3. The head chip 2502 has half the discharge amount of Bk to be equal to other chips of Bk and CMY, thereby achieving an exact application position.

[0156] The tank 2500-1 (for Bk1 + S + Bk2) is the same as in the embodiment 1, and detailed description thereof is omitted. Further, the tanks 2510-2C, M, Y are the same as those in the embodiment 2, and detailed description thereof is omitted. To supply each ink, the sponge portion of the tanks 2510-1, 2510-2C, M, Y is contacted close to the filters 2523-1, 2523-2C, M, Y of the heads 2500-1, 2500-2, and sucked sequentially or simultaneously by the main unit recovery means (not shown).

[0157] The present embodiment is characterized in that thinning for reducing the consumption of the print improving liquid is not made, but the discharge amount of the print improving liquid is decreased to a half of the discharge amount of Bk to arrange in dot-on-dot at the Bk dot position, thereby reducing the load of image processing and enabling high-speed recording. In this case, at the Bk dot position, the print improving liquid is always discharged in an amount of half the ink. With this arrangement, the discharge amount of the print improving liquid is reduced to obtain the same effect as thinning. In the present embodiment, the discharge amount is decreased to about a half, however, the discharge amount of the print improving liquid may be selected according to the recording method, ink composition, recording medium, image, and the thinning effect. In this case, the discharge amount is not always halved, for example, according to the image data, the discharge amount may be varied according to various conditions such that the amount is less than a half for a highlight portion, and increased for an overall printing portion. Further, an effect to increase the contact area by sandwiching the print improving liquid with the Bk ink as described in the embodiment 3 to enhance the action of the print improving liquid is also obtained. The above contact area is present both on the upper side and the lower side, about twice the contact area can be obtained to enhance the reaction efficiency. As described above, as an effect of the Bk + S + Bk system, first in Bk + S the Bk ink penetrates into the printing medium to some extent and spreads, a white portion is reduced, and the area factor can be increased. Next, a further effect is obtained that when Bk is overlapped, the secondary discharged Bk ink is difficult to penetrate into the printing medium due to the previous Bk + S reaction, and easy to remain on the surface of the printing medium to improve the image density, and provides water resistance due to the reaction with residual print improving liquid.

(Examples of other head structures)

[0158] Fig. 28 to Fig. 31, as other embodiments of the present invention, show examples when the print improving liquid is sandwiched between other colored ink nozzles in a vertical integral head structure. In Fig. 28, the same structure as the embodiment 2 is formed of a nozzle arrangement of vertical heads, in which the Bk chip 2501, the S chip 2502, the C chip 2503, the M chip 2504, and the Y chip 2505 are vertically arranged. Further, Fig. 29 shows a sandwich structure by colored inks (Bk) also in a vertical head structure, in which an S1 chip 2502 is sandwiched between Bk chips 2601 and 2603, and further an S2 chip 2604, a C chip 2605, an M chip 2606, and a Y chip 2607 are vertically arranged. Fig. 30 shows a case where the print improving liquid is sandwiched between all the colored inks, and a Bk chip 2701, an S1 chip 2702, a C chip 2703, an S2 chip 2704, an M chip 2705, an S chip 2706, and a Y chip 2707 are vertically arranged. In Fig. 31, when forming a nozzle by vertically arranging a Bk chip 2801, an S chip 2802, and a Bk chip 2803, the nozzles of the Bk chip 2801 and the S chip 2802 are designed to be shifted by a half picture element, thereby obtaining a shift effect of the print improving liquid while maintaining the paper feed at a constant even with a vertical head structure. Further, since the Bk1 chip 2801 and the Bk2 chip 2803 are individually shifted by a 1/2 picture element in the reliquid direction, when printing at half the printing speed in the main scanning direction, a 720 dpi printing is possible in 2-pass. It is needless to say that in an integral head structure, the suction cap and the head structure must be devised so that the print improving liquid and colored inks do not mix during suction recovery.

[0159] Further, as other embodiments of the present invention, Fig. 32 to Fig. 34 show cases where the head structures of embodiments 1 to 6 are formed of separate type (combination of separate/independent heads) units. Specifically, as shown in Fig. 32, for example, 3-chip integral type (Fig. 32A) of the head of the embodiment 1 can be formed as a unit of a 2-chip integral type and 1 chip (Fig. 32B), or a unit can be formed with three independent chips (Fig. 32C). Further, as shown in Fig. 33, the 3-chip integral type head of the embodiment 2 (Fig. 33A) can be divided into a unit of a 2-chip integral type of Bk and S and a CMY chip (Fig. 33B), or a unit can be formed with three independent chips. Still further, as shown in Fig. 34, the 6-chip integral type head of. the embodiment 5 (Fig. 34A) may be formed

into a unit by combining two units of 3-chip integral type (Fig. 34B), into a unit by combining a 3-chip integral type with three independent chips (Fig. 34C), or into a unit by combining six independent chips. It is needless to say that even with these head structures, the same effect can be obtained irrespective of the type of head structure if the structure to sandwich the print improving liquid between colored inks is used as in the above description. By using such structures, the chips can be commonly used to reduce the cost.

[0160] Yet further, it is needless to say that the same effect can be obtained if the arrangement for sandwiching the print improving liquid between colored inks is used even in prior art printing techniques, such as a head structure equipped with inks of different concentrations such as concentrated/diluted inks, or a multi-droplet printing system (including shifting of application position) for forming an image by a plurality of dots in a single picture element.

(Examples of ink composition)

[0161] Composition of the ink and print improving liquid used above is, for example, as follows.

CASE 1: when all the inks are dyestuff inks

[0162]

Y ink	
	(parts by weight)
Glycerin	5.0
Thiodiglycol	5.0
Urea	5.0
Isopropylalcohol	4.0
Dye C. I. Direct Yellow 142	2.0
Water	79.0

M ink	
	(parts by wt.)
Glycerin	5.0
Thiodiglycol	5.0
Urea	5.0
Isopropylalcohol	4.0
Dye C. I. Acid Red 289	2.5
Water	78.5

C ink	
	(parts by wt.)
Glycerin	5.0
Thiodiglycol	5.0
Urea	5.0
Isopropylalcohol	4.0
Dye C. I. Direct Blue 199	2.5
Water	78.5

Bk ink	
	(parts by wt.)
Glycerin	5.0

(continued)

Bk ink	
	(parts by wt.)
Thiodiglycol	5.0
Urea	5.0
Isopropylalcohol	4.0
Dye Food Black 2	3.0
Water	78.5

Print improving liquid	
	(parts by wt.)
Polyarylamine hydrochloride	5.0
Benzalconium chloride	1.0
Diethyleneglycol	10.0
Acetylenol EH (Kawaken Chemical)	0.8
Water	83.5

[0163] In mixing the individual print improving liquid (here, referred to as treatment liquid (liquid composition)) with ink, in the present invention, the treatment liquid and ink are mixed on the printing medium or at a position penetrated in the printing medium, as a first step of reaction, of the cationic substances contained in the treatment liquid, a low-molecular weight component or a cationic oligomer undergoes association with a water-soluble dye having an anionic group used in the ink or an anionic compound used in the pigment ink due to an ionic interaction, momentarily resulting in separation from the liquid phase. As a result, dispersion destruction occurs in the pigment ink to form a coagulate of pigment.

[0164] Next, as a second step of the reaction, the above associate of the dye with the low-molecular weight cationic substance or the cationic oligomer or the coagulate of pigment is adsorbed by a polymer component contained in the treatment liquid, the size of the aggregate of dye or the aggregate of pigment resulting from association becomes even larger, and becomes difficult to come into voids between fibers of the printing medium. As a result, only the liquid part of the solid/liquid separation penetrates into the printing medium, thereby achieving both the print quality and fixing. At the same time, the aggregate formed of the low molecular weight component or the cationic oligomer and the anionic dye and the cationic substance produced by the above mechanism or the aggregate of pigment increases in viscosity, does not move along with movement of the liquid medium, even when the adjacent ink dot is formed of a different color as in full-color image formation, they do not mix up with each other, and no bleeding occurs. Further, the above aggregates are substantially insoluble in water, and the formed image has a perfect water resistance. Still further, light fastness of the image formed is also improved due to a shielding effect of the polymer.

[0165] As insolubilization or aggregation used in the present specification, an example is a phenomenon only of the above first step, and another example is phenomena including both the first and second steps.

[0166] Further, in executing the present invention, a high molecular weight cationic polymer substance or a polyvalent metal salt is not required to be used as in the prior art, or if required to use, it may be used as auxiliary for even further improving the effect of the present invention, and the amount can be decreased to a minimum. As a result, degradation of color development of dye is eliminated as another effect of the present invention, which has been a problem of using a prior art cationic polymer substance or a polyvalent metal salt to obtain a water resistance.

[0167] The printing medium used in using the present invention is not specifically limited, but so-called plain paper such as conventionally used copy paper, bond paper, or the like can be advantageously used. Of course, coated paper specially prepared for ink jet printing or OHP transparent film can also be used to good advantage, and general fine paper or gloss paper can be used.

[0168] Further, in executing the present invention, the ink is not specifically limited to dyestuff inks, but pigment inks of dispersed pigment can be used, and the treatment liquid may be one which agglomerates the pigment. The following is shown as an example of pigment ink which is mixed with the colorless liquid A1 to cause agglomeration. That is, colored inks Y2, M2, C2, and K2 of yellow, magenta, cyan, and black containing the individual pigments and an anionic compound can be obtained as follows.

[Black ink K2]

[0169] Using an anionic polymer P-1 (styrene-methacrylic acid-ethylacrylate, acid value 400, weight average molecular weight 6,000, aqueous liquid of 20% solid content, neutralizing agent: potassium hydroxide) as a dispersant, the following materials were charged into a batch type vertical sand mill (AIMEX), 1 mm diameter glass beads were added as media, and dispersed for 3 hours under water cooling. The viscosity after dispersion was 9 cps, the pH was 10.0. The dispersion was subjected to a centrifuge to remove coarse particles, to obtain a carbon black dispersion with a weight average particle diameter of 100 nm.

(Composition of carbon black dispersion)	
	(parts)
P-1 aqueous liquid (20% solid)	40
Carbon black Mogul L (CABLACK)	24
Glycerin	15
Ethyleneglycolmonobutylether	0.5
Isopropylalcohol	3
Water	135

[0170] Then, the above-obtained dispersion was thoroughly dispersed to obtain a black ink K2 for ink jet printing. The solid content of the final composition was about 10%.

[Yellow ink Y2]

[0171] Using an anionic polymer P-2 (styrene-acrylic acid-methylmethacrylate, acid value 280, weight average molecular weight 11000, aqueous liquid of 20% solid content, neutralizing agent: diethanolamine) as a dispersant, the following materials were treated as in the preparation of black ink K2 to obtain a yellow color dispersion with a weight average particle diameter of 103 nm.

(Composition of yellow dispersion)	
	(parts)
P-2 aqueous liquid (20% solid)	35
C. I. Pigment Yellow 180 (NOVAPALM YELLOW PH-G Hoechst)	24
Triethyleneglycol	10
Diethyleneglycol	10
Ethyleneglyoclmonobutylether	1.0
Isopropylalcohol	0.5
Water	135

[0172] Then, the above-obtained dispersion was thoroughly dispersed to obtain a yellow ink Y2 for ink jet printing. The solid content of the final composition was about 10%.

[Cyan ink C2]

[0173] Using the anionic polymer P-1 used in the preparation of the black ink K2 as a dispersant, the following materials were treated as in the preparation of the carbon black dispersion to obtain a cyan color dispersion with a weight average particle diameter of 120 nm.

(Composition of cyan dispersion)	
	(parts)
P-1 aqueous liquid (20% solid)	30
C. I. Pigment Blue 15:3 (FASTGENBLUE PGF, Dainippon Ink and Chemicals)	24

(continued)

(Composition of cyan dispersion)	
	(parts)
Glycerin	15
Diethyleneglycolmonobutylether	0.5
Isopropylalcohol	3
Water	135

[0174] The above-obtained cyan dispersion was thoroughly agitated to obtain a cyan ink C2 for ink jet printing containing pigment. The solid content of the final composition was about 9.6%.

[Magenta ink C2]

[0175] Using the anionic polymer P-1 used in the preparation of the black ink K2 as a dispersant, the following materials were treated as in the preparation of the carbon black dispersion to obtain a magenta color dispersion with a weight average particle diameter of 115 nm.

(Composition of magenta dispersion)	
	(parts)
P-1 aqueous liquid (20% solid)	20
C. I. Pigment Red 122 (Dainippon Ink and Chemicals)	24
Glycerin	15
Isopropylalcohol	3
Water	135

[0176] The above-obtained magenta dispersion was thoroughly dispersed to obtain a magenta ink M2 for ink jet printing containing pigment. The solid content of the final composition was about 9.2%.

[0177] Here, examples of using dyes as color materials of Y, M, C, Bk inks have been shown, however, the present invention is not limited to the examples, but those which use pigments as color materials, or dyes and pigments in combination, may be used. The same effect can be obtained by using the print improving liquid which is optimum for agglomerating the individual inks containing the color materials.

(Others)

[0178] The present invention, particularly among ink jet recording systems, provides advantageous effects in recording heads or recording apparatus equipped with means for generating a heat energy as energy utilized for ink discharge (e.g. electrothermal converter or laser light) to cause state changes of the ink by the heat energy. High density and fine recording is achieved with such systems.

[0179] On the typical constructions and principles, it is preferable to use those which operate using the basic principles disclosed, for example, in U.S. Patent Nos. 4723129, and 4740796. This system is operable by any of so-called on-demand type and a continuous type, particularly, in the on-demand type, heat energy is generated in an electrothermal converter by applying at least a drive signal for giving a rapid temperature increase exceeding nuclear boiling corresponding to recording information to the electrothermal converter disposed according to the sheet or liquid passage in which a liquid (ink) is maintained, to generate film boiling on the heat applying surface of the recording head, and as a result, to form bubbles in the liquid (ink) one-to-one corresponding to the drive signal. The liquid (ink) is discharged through a discharge opening by growth or contraction of the bubbles to form at least a drop. When the drive signal is formed in pulses, since growth and contraction of the bubbles is made immediately and appropriately, discharge of liquid (ink) of particularly superior in response can be achieved, which is more preferable. As the pulse-formed drive signal, those which are described in U.S. Patent Nos. 4463359 and 4345262 are suitable. More superior recording can be made when the condition described in U.S. Patent No. 4313124 which is an invention relating to the temperature increasing rate of the heating surface.

[0180] As to the construction of the recording head, constructions using U.S. Patent Nos. 4558333 and 4459600 disclosing constructions in which the heat applying portion is disposed on a bending area in addition to combination

constructions of the discharge port, liquid passage, and electrothermal converter as disclosed in the above patents are also included in the present invention. In addition, the effect of the present invention is effective for the construction based on Japanese Patent Application Laid-open No. 123670/1984 disclosing a construction in which a common slit is used as a discharge port of the electrothermal converter for a plurality of electrothermal converters or a construction based on Japanese Patent Application Laid-open No. 138461/1984 disclosing a construction in which an opening for absorbing a pressure wave of heat energy is disposed in correspondence to the discharge port. That is, even with any configuration of the recording head, the present invention can provide positive and efficient recording.

[0181] Further, the present invention can be effectively applied to a full-line type recording head having a length corresponding to the maximum width of the recording medium that can be recorded by the recording apparatus. Such a recording head may be any of a construction which satisfies the length by combination of a plurality of recording heads, and a construction as an integrally-formed single recording head.

[0182] In addition, even with the above serial type, the present invention is also effective when using a recording head mounted on the apparatus main unit, a recording head of a replaceable chip type in which electrical connection with the apparatus main unit and supply of ink from the main unit are possible by mounting on the main unit, or a cartridge type recording head in which the ink tank is integrally provided on the recording head itself.

[0183] Further, addition of recovery means or preparative auxiliary means to the recording head, which are provided as components of the recording apparatus is preferable because they can even further stabilize the effect of the present invention. Specifically, capping means for the recording head, cleaning means, pressure or suction means, a heating element separate from the electrothermal converter, preparatory heating means by combining these devices, and preparatory discharge mode for discharging separate from recording are also effective for stable recording.

[0184] Still further, as to the type and number of recording heads used, for example, in addition to one which is provided with only one head for a monocolor ink, a plurality of recording heads may be provided according to a plurality of inks of different recording colors or densities. That is, not only a recording mode of only main colors such as black or the like as a recording mode of the recording apparatus, but also the recording head may be integrally structured or a plurality of recording heads may be combined, and the present invention is very effective for an apparatus having at least of a multicolor of different colors and a full-color of mixed colors.

[0185] In addition, in the above-described embodiments of-the present invention, the ink is described as a liquid, however, since it is usual to use an ink which solidifies at or below room temperature and softens or liquefies at room temperature, or in the ink jet system, the ink itself is temperature controlled in the range from 30°C to 70°C so that the ink viscosity is within the stable discharge range, the ink may be in the liquid state when applying the operation recording signal. Further, the present invention is operable when preventing temperature increase due to heat energy by utilizing it as an energy for state change from solid to liquid of the ink, or using an ink which solidifies when being allowed to stand for preventing evaporation of the ink. The present invention can be applied when an ink is used which liquefies for the first time by a heat energy, such as one which liquefies when it reaches the recording medium and a liquid ink is discharged, or which begins to solidify when it reaches the recording medium. An ink usable in such a case may have a state maintained as a liquid or solid in a recess or through-hole in a porous sheet, opposing the electrothermal converter, as described in Japanese Patent Application Laid-open No. 56847/1979 or 71260/1985. In the present invention, the above-described film boiling type is the most effective.

[0186] In addition, the configuration of the recording apparatus provided with a recording mechanism using the liquid jet discharge recording head may be one which is used as an image output terminal of information processing apparatus such as a computer, a copier combined with a reader or the like, or a facsimile apparatus having a transmission function.

[0187] Fig. 35 is a block diagram showing the construction when the recording apparatus of the present invention is applied to an information processing apparatus having a function as word processor, personal computer, facsimile, or copier.

[0188] In the Figure, the numeral 1801 indicates a control unit for controlling the entire apparatus, having a CPU such as a microprocessor or the like or various I/O ports, to output control signals or data signals to various units or receive control signals or data signals from various units to make control. The numeral 1802 indicates a display unit, which displays various menus and image data received by an image reader 1807 on the display screen. The numeral 1803 indicates a transparent pressure-sensitive touch panel provided on the display unit 1802, which by pressing the surface by a finger, makes item input or coordinate input on the display unit 1802.

[0189] The numeral 1804 is an FM (Frequency Modulation) sound source unit, which stores music information prepared by a music editor or the like as digital data in a memory unit 1810 or an external recording apparatus 1812, and reads it from the memory or the like to make FM modulation. Electrical signal from the FM sound source unit 1804 is converted to audible sound by a speaker unit 1805. A printer unit 1806 is applied with the recording apparatus of the present invention as an output terminal of the word processor, personal computer, facsimile, or copier.

[0190] The numeral 1807 is an image reader unit which optoelectrically reads document data to input it, and reads a facsimile document, copying document, or other documents. The numeral 1808 is a transmission/reception unit of facsimile (FAX) which receives and decodes a facsimile signal, and has an interface function with external apparatus.

The numeral 1809 is a telephone unit having an ordinary telephone function or a caretaking function.

[0191] The numeral 1810 is a memory unit including ROM for storing a system program, a manager program, other application programs, character fonts, and a dictionary, or application programs, document information, and video RAM loaded from an external memory apparatus 1812.

[0192] The numeral 1811 is a keyboard unit for inputting document information or various commands.

[0193] The external memory apparatus 1812, which uses recording media such as a floppy disk or hard disk, stores document information, music or voice information, user application programs or the like.

[0194] Fig. 36 is a schematic outer view of an information processing apparatus shown in Fig. 35.

[0195] In the Figure, the numeral 1901 indicates a flat panel display utilizing liquid crystals or the like for displaying various menus, figure information, and document information. The display 1901 is provided thereon with the touch panel 1803, which can be pressed on the surface by a finger for making coordinate input or item designation input. The numeral 1902 is a hand set used when the apparatus functions as a telephone. A keyboard 1903 is detachably connected to the main unit through a cord for inputting various document information and various data. Further, the keyboard 1903 is provided with various keys 1904 and the like.

[0196] The numeral 1905 is a floppy disk insertion port to an external memory apparatus 212.

[0197] The numeral 1906 is a paper piling unit for placing an original to be ready by the image reader unit 1807, and the read original is discharged from the rear of the apparatus. In facsimile reception, the output is recorded by an ink jet printer 1907.

[0198] The display unit 1802 may be a CRT, but it is preferable to use a flat panel such as liquid crystal display utilizing a ferroelectric liquid crystal, which is compact, thin-formed, and lightweight.

[0199] When the information processing apparatus is functioned as a personal computer or a word processor, various information input from a keyboard unit 211 is processed according to a predetermined program by the control unit 1801 and output as an image to the printer unit 1806.

[0200] When the information processing apparatus is functioned as a facsimile receiver, facsimile information input from the FAX transmission/reception unit 1808 through a communication line is processed according to a predetermined program by the control unit 1801, and output as a reception image to the printer unit 1806.

[0201] When it functions as a copier, the original is read by the image reader unit 1807, the read original data is output as a copy image to the printer unit 1806 through the control unit 1801. When it functions as a facsimile receiver, original data read by the image reader unit 1807 is transmission processed according to a predetermined program by the control unit 1801, and transmitted to the communication line through the FAX transmission/reception unit 1808.

[0202] The above information processing apparatus may be structured as an integrated type in which the ink jet printer is incorporated in the main unit as shown in Fig. 37. This enhances the portability. In the Figure, parts having similar functions to Fig. 35 are indicated by similar reference numerals.

[0203] Since, by applying the recording apparatus of the present invention to the above-described multifunctional information processing apparatus, the functions of the information processing apparatus can be improved even further.

[0204] As described above, the present invention can provide how to arrange and control the head structure and printing method for making pre-feed / follow feed, in order to sufficiently provide the effects of pre-feed / follow feed (penetration control, blotting prevention, improvement of fixing, elimination of feathering, reduction of bleeding, reduction of unevenness/stripes). In particular, the present invention can provide a head structure suitable for optimally utilizing the pre-feed / follow feed in ink jet printing, and a print control method (including image improving techniques applying head control/image processing) for optimally utilizing the pre-feed / follow feed in ink jet printing. Further, it can provide optimum combinations of inks (CMY/K/print improving liquid) for optimally utilizing the pre-feed / follow feed in ink jet printing and ink compositions thereof, and an ink jet printing apparatus capable of achieving both high speed/high image quality by the pre-feed / follow feed at a low cost. Further, the present invention can provide an effect of reducing the ink consumption and improvement of printing speed in combination with the effect of the conventional pre-feed / follow feed technique.

[0205] The present invention has been described in detail with respect to preferred embodiments, and it will now be that changes and modifications may be made without departing from the invention in its broader aspects, and it is intention, therefore, in the appended claims to cover all such changes and modifications as fall within the scope of the invention.

Claims

1. An ink jet head comprising:

a first ink discharge portion (BK1) for discharging an ink;
a liquid discharge portion (S) for discharging a liquid containing at least a print improving liquid for rendering

insoluble or aggregating a dye or a pigment in an ink; and
a second ink discharge portion (BK2) for discharging ink, **characterised in that** the first ink, liquid and second ink discharge portions are arranged **in that** order in a predetermined direction.

2. An ink jet head as claimed in claim 1, wherein said first ink discharge portion (BK1) and said second ink discharge portion (BK2) contain ink of the same color.

3. An ink jet head as claimed in claim 2, wherein said first and second inks are black inks.

4. An ink jet head as claimed in claim 2, wherein said first and second inks are black inks and the head further comprises a third ink discharge portion (2103) for discharging inks other than black ink, said first ink, liquid, second ink, and third ink discharge portions being arranged in that order and said black and other inks being such that, in use of the head to print on a print medium, penetration of the black ink from said first and second discharge portions into the print medium is lower than that of ink from said third discharge portion and the liquid contains a component which insolubilizes or coagulates a coloring material in black ink from said first and second discharge portions.

5. An ink jet head as claimed in claim 2, wherein said first ink discharge portion is a first black ink discharge portion (2125-BK), said second ink discharge portion (2105) is a second black ink discharge portion, and the head further comprises a cyan ink discharge portion (2125-C), a magenta ink discharge portion (2125-M), and a yellow ink discharge portion (2125-Y) with the discharge portions arranged in that order.

6. An ink jet head as claimed in claim 1, wherein said first ink discharge portion (2125) and said second ink discharge portion (2105) contain ink of different colors.

7. An ink jet head as claimed in claim 6, wherein said first ink is a black ink and said second ink discharge portion comprises an integrated arrangement consisting of a plurality of different color ink discharge portions wherein said colors are different from black.

8. An ink jet head as claimed claim 1, comprising at least two ink discharge portions for discharging the same color of ink each having an array of discharge outlets and being arranged so as to be shifted relative to one another in the direction of the array, the direction perpendicular to the array or both directions by an odd number of times of ½ a discharge outlet pitch of said discharge portions.

9. An ink jet head as claimed in claim 8, wherein said same color ink discharge portions are shifted relative to one another by about ½ the discharge outlet pitch in the array direction.

10. An ink jet head as claimed in any one of claims 1 to 9, having a head unit structure wherein head chips constituting said individual discharge portions are provided in an integral type frame.

11. An ink jet head as claimed in any one of claims 1 to 9, having a plurality of head unit structures incorporating head chips constituting said individual discharge heads combined in an integral type frame.

12. An ink jet head as claimed in any one of claims 1 to 11, wherein said discharge portions have an energy generating element for generating energy to cause discharge of ink or print improving liquid.

13. An ink jet head as claimed in any one of claims 1 to 12, wherein said liquid discharge portion provides print improving liquid containing a cationic substance of a low molecular weight component and a high molecular weight component, and said ink contains an anionic dye.

14. An ink jet head as claimed in any one of claims 1 to 12, wherein said liquid discharge portion provides print improving liquid containing a cationic substance of a low molecular weight component and a high molecular weight component, and said ink contains an anionic dye or at least an anionic compound and a pigment.

15. An ink jet head as claimed in claim 1, wherein said ink is a black ink being lower in penetration of a print medium than a colored ink.

16. An ink jet printing apparatus for printing on a print medium by discharging ink onto the print medium, the apparatus comprising an ink jet head according to any one of claims 1 to 15.

17. An ink jet printing apparatus according to claim 16, comprising:

main scan means for reciprocably scanning said ink jet head in outward and return directions along a main scan path across a print medium; and

discharge control means for controlling discharge from said ink and liquid discharge portions in accordance with data to be printed, the discharge control means being arranged to cause print improving liquid to be sandwiched between ink on the print medium with respect to a direction perpendicular to the surface of the print medium.

18. An ink jet printing apparatus according to claim 17, wherein said discharge control means is arranged to cause discharge of print improving liquid from said liquid discharge portion in an outward main scan, discharge of ink from said ink discharge portion, discharge of print improving liquid from said liquid discharge portion in a return main scan, and discharge of ink from said ink discharge portion.

19. An ink jet printing apparatus according to claim 17, wherein said discharge control means is arranged to cause discharge of ink from said ink discharge portion in an outward main scan, discharge of print improving liquid from said liquid discharge portion, discharge of ink from said ink discharge portion in a return main scan, and discharge of print improving liquid from said liquid discharge portion.

20. An ink jet printing apparatus according to claim 17, wherein said discharge control means is arranged to cause discharge of print improving liquid from said liquid discharge portion in an outward main scan, discharge of ink from said ink discharge portion, discharge of print improving liquid from said liquid discharge portion in a return main scan, discharge of ink from said ink discharge portion, and discharge of print improving liquid from said liquid discharge portion.

21. An ink jet printing apparatus comprising a main unit and an ink jet head according to any one of claims 1 to 15 detachably mounted to the main unit.

22. An ink jet printing apparatus as claimed in claim 21 when dependent on claim 10 or 11, having means for identifying individual head units for optimized control.

23. An ink jet printing apparatus as claimed in claim 21 or claim 22, further comprising print control means for controlling discharge from said discharge portions to form an image on a print medium so that print improving liquid discharged from said liquid discharge portion is sandwiched between inks discharged from said ink discharge portions.

24. An ink jet printing apparatus as claimed in claim 23, wherein said print control means is arranged to cause said inks sandwiching said print improving liquid to be the same color.

25. An ink jet printing apparatus as claimed in claim 23, wherein said print control means is arranged to cause said inks sandwiching said print improving liquid to be different in color.

26. An ink jet printing apparatus as claimed in claim 23, wherein said print control means is arranged to cause said inks sandwiching said print improving liquid to have different compositions.

27. An ink jet printing apparatus as claimed in claim 26, wherein one of said different compositions is a super-penetrating type solvent composition penetrating in a moment into the print medium, and the other is an overlaying type solvent composition penetrating gradually into the print medium.

28. An apparatus according to any one of claims 21 to 27, further comprising main scan means for effecting relative movement between said ink jet head and a print medium to cause the ink jet head to scan a main scan path across the print medium.

29. An ink jet printing apparatus as claimed in any one of claims 23 to 27, further comprising main scan means for effecting relative movement between said ink jet head and a print medium to cause the ink jet head to scan a main scan path across the print medium, the arrangement being such that, in use, print improving liquid discharged from said liquid discharge portion is located at a position shifted by ½ picture element relative to an ink picture element on the print medium in the main scan direction or a sub-scan direction.

30. An ink jet printing apparatus as claimed in claim 28 or 29, wherein said print control means is capable of causing 1-pass bidirectional printing.

31. An ink jet printing apparatus as claimed in claim 28 or 29, wherein said print control means is capable of causing 1-pass unidirectional printing.

32. An ink jet printing apparatus as claimed in claim 28 or 29, wherein said print control means is capable of causing 2-pass bidirectional printing.

33. An ink jet printing apparatus as claimed in claim 28 or 29, wherein said print control means is capable of causing 2-pass unidirectional printing.

34. An ink jet printing apparatus as claimed in claim 28 or 29, wherein said print control means is capable of causing N (N being a positive number)-pass bidirectional printing.

35. An ink jet printing apparatus as claimed in claim 28 or 29, wherein said print control means is capable of causing N (N being a positive number)-pass unidirectional printing.

36. An ink jet head printing apparatus as claimed in claim 17, 18, 19 or 20, comprising an ink jet head wherein said first ink discharge portion is a black ink discharge portion, and said second ink discharge portion comprises a plurality of different color ink discharge portions and the ink jet head is mounted to the apparatus such that the first ink discharge portion, liquid discharge portion and second ink discharge portion are arranged in that order along the main scan path.

37. An ink jet printing apparatus as claimed in claim 17, 18, 19 or 20, comprising an ink jet head having first and second black ink discharge portions, a liquid discharge portion for discharging print improving liquid and a third discharge portion for discharging inks other than black, said first ink, liquid, second ink, and third ink discharge portions being arranged in that order along the main scan path and the black and other color inks being such that, in use, penetration of the black ink from said first and second discharge portions into a print medium is lower than that of the inks from said third ink discharge portion, and wherein said discharge control means is operable to cause a black image to be formed on the print medium by black ink discharged from said first ink discharge portion, liquid discharged from said liquid discharge portion, and black ink discharged from said second ink discharge portion in that order so as to overlap the print medium, the liquid containing a component which insolubilizes or coagulates a coloring material in black ink from said first and second ink discharge portions.

38. An ink jet printing apparatus as claimed in claim 17, 18, 19 or 20, comprising an ink jet head having arranged along a main scan direction a first black ink discharge portion, said print improving liquid discharge portion, a second black ink discharge portion, a cyan ink discharge portion, a magenta ink discharge portion and a yellow ink discharge portion.

39. An ink jet printing apparatus as claimed in claim 17, 18, 19 or 20, comprising an ink jet head having two or more ink discharge portions having discharge outlet arrays for discharging the same color ink, disposed shifted relative to one another by an odd number times of ½ a discharge outlet pitch of said discharge portions in a main scan direction, a sub-scan direction or both.

40. An ink jet printing apparatus according to claim 20 when dependent upon claim 4, further comprising a mounting section detachably mounting the ink jet head wherein the ink jet printing apparatus is adapted to form a black image on a print medium by applying black ink discharged from said first ink discharge portion, liquid discharged from said liquid discharge portion, the black ink discharged from said second ink discharge portion in this order onto the print medium, overlappedly.

41. An ink jet printing method for producing a printed product **characterised by** using an ink jet head according to any one of claims 1 to 15.

42. An ink jet printing method according to claim 41, wherein said method comprises the steps of:

in an outward main scan of the ink jet head relative to a print medium, discharging said print improving liquid from said liquid discharge portion onto said print medium, and discharging ink from said ink discharge portion

so that the ink overlaps with said liquid discharged on said print medium; and
in a return main scan, discharging print improving liquid from said liquid discharge portion so that the liquid overlaps with said ink discharged in said outward main scan, and discharging said ink from said ink discharge portion so as to overlap with said liquid discharged in the return scan so that said print improving liquid is sandwiched between inks on the print medium with respect to a direction perpendicular to the surface of the print medium to form an image.

43. An ink jet printing method according to claim 41, wherein said method comprises the steps of:

in an outward main scan of the ink jet head relative to a print medium, discharging ink from said ink discharge portion onto said print medium, and discharging print improving liquid from said liquid discharge portion so as to overlap with said ink discharged on said printing medium; and
in a return main scan, discharging ink from said ink discharge portion so as to overlap with said liquid discharged in said outward scan, and discharging print improving liquid from said liquid discharge portion so as to overlap with said ink discharged in this return scan, so that said print improving liquid is sandwiched between inks on the print medium with respect to a direction perpendicular to the surface of the print medium.

44. An ink jet printing method according to claim 41, wherein said method comprises the steps of:

in an outward main scan of the ink jet head relative to a print medium, discharging print improving liquid from said liquid discharge portion onto said print medium, discharging ink from said ink discharge portion so as to overlap with said liquid discharged on said printing medium, and discharging print improving liquid from said liquid discharge portion so as to overlap with said ink discharged on said liquid which is discharged on said print medium; and
in a return main scan, discharging print improving liquid from said liquid discharge portion so as to overlap with said liquid discharged last in said outward scan, discharging ink from said ink discharge portion so as to overlap with said liquid discharged in this return scan, and discharging print improving liquid from said liquid discharge portion so as to overlap with ink discharged in this return scan, so that said print improving liquid is sandwiched between inks on the print medium with respect to a direction perpendicular to the surface of the print medium.

45. An ink jet printing method according to claim 41, wherein said method comprises the steps of:

in a main scan of said ink jet head relative to a print medium, discharging print improving liquid from said liquid discharge portion onto said print medium, discharging ink from said ink discharge portion so as to overlap with said liquid discharged on said print medium; and discharging print improving liquid from said liquid discharge portion so as to overlap with said ink discharged on said liquid which is discharged on said print medium so that said ink is sandwiched between said liquids on the printing medium with respect to a direction perpendicular to the surface of the print medium.

46. An ink jet cartridge comprising an ink jet head according to any one of claims 1 to 15 and an ink tank provided detachably on said ink jet head.

47. A printed product comprising a print medium having an image formed thereon by ink provided from an ink jet head according to any one of claims 1 to 15, and a print improving liquid for rendering insoluble or aggregating a dye or a pigment in an ink, wherein said print improving liquid is sandwiched between at least one set of colored inks on the print medium.

48. A printed product as claimed in claim 47, wherein said print improving liquid is disposed at a position shifted by ½ a picture element relative to an ink picture element on the print medium in a main scanning direction, a sub-scanning direction, or both.

49. A printed product as claimed in claim 47 or claim 48, wherein said colored inks are the same in color.

50. A printed product as claimed in claim 47 or claim 48, **characterized in that** said colored inks are different in color.

51. A printed product as claimed in claim 47, wherein an amount of component of said print improving liquid present at the center of the sandwich is higher than amounts of individual components of inks sandwiching said print

improving liquid.

52. A control device for an ink jet printing apparatus for printing on a print medium using an ink jet head according to any one of claims 1 to 15, the control device comprising:

discharge control means for causing discharge of ink from the ink discharge portion, then causing discharge of liquid from said liquid discharge portion and then causing discharge of more ink from a discharge portion so that the print improving liquid is sandwiched between ink on the print medium with respect to a direction perpendicular to the surface of the print medium.

Patentansprüche

1. Tintenstrahlkopf, der aufweist:

- einen ersten Tintenausstoßabschnitt (Bk1) zum Ausstoß einer Tinte,
- einen Flüssigkeitsausstoßabschnitt (S) zum Ausstoß einer Flüssigkeit, die mindestens eine druckverbessernde Flüssigkeit zum Unlöslichmachen oder Aggregieren eines Farbstoffs oder eines Pigments in einer Tinte enthält, und
- einen zweiten Tintenausstoßabschnitt (Bk2) zum Ausstoß von Tinte,

dadurch gekennzeichnet, daß

der erste Tintenausstoßabschnitt, der Flüssigkeitsausstoßabschnitt und der zweite Tintenausstoßabschnitt in dieser Reihenfolge in einer vorbestimmten Richtung angeordnet sind.

2. Tintenstrahlkopf gemäß Anspruch 1, wobei der erste Tintenausstoßabschnitt (Bk1) und der zweite Tintenausstoßabschnitt (Bk2) Tinte der gleichen Farbe enthalten.

3. Tintenstrahlkopf gemäß Anspruch 2, wobei die erste Tinte und die zweite Tinte Schwarztinten sind.

4. Tintenstrahlkopf gemäß Anspruch 2, wobei die erste Tinte und die zweite Tinte Schwarztinten sind und der Kopf ferner einen dritten Tintenausstoßabschnitt (2103) zum Ausstoß von Tinten anders als Schwarztinte aufweist, wobei der erste Tintenausstoßabschnitt, der Flüssigkeitsausstoßabschnitt, der zweite Tintenausstoßabschnitt und der dritte Tintenausstoßabschnitt in dieser Reihenfolge angeordnet sind und die Schwarztinte und andere Tinten derart sind, daß bei Verwendung des Kopfs zum Drucken auf einem Druckmedium das Eindringvermögen der Schwarztinte aus dem ersten Ausstoßabschnitt und dem zweiten Ausstoßabschnitt in das Druckmedium geringer als das von Tinte aus dem dritten Ausstoßabschnitt ist und die Flüssigkeit eine Komponente enthält, welche ein Farbausbildungsmaterial in der Schwarztinte aus dem ersten Ausstoßabschnitt und dem zweiten Ausstoßabschnitt unlöslich macht oder koaguliert.

5. Tintenstrahlkopf gemäß Anspruch 2, wobei der erste Tintenausstoßabschnitt ein erster Schwarztinten-Ausstoßabschnitt (2125-Bk) ist, der zweite Tintenausstoßabschnitt (2105) ein zweiter Schwarztinten-Ausstoßabschnitt ist und der Kopf ferner einen Cyantinten-Ausstoßabschnitt (2125-C) aufweist, einen Magentatinten-Ausstoßabschnitt (2125-M) und einen Gelbtinten-Ausstoßabschnitt (2125-Y) mit den in dieser Reihenfolge angeordneten Ausstoßabschnitten.

6. Tintenstrahlkopf gemäß Anspruch 1, wobei der erste Tintenausstoßabschnitt (2125) und der zweite Tintenausstoßabschnitt (2105) Tinten unterschiedlicher Farben enthalten.

7. Tintenstrahlkopf gemäß Anspruch 6, wobei die erste Tinte eine Schwarztinte ist und der zweite Tintenausstoßabschnitt einen einstückigen Aufbau aufweist, der aus einer Vielzahl von Ausstoßabschnitten für unterschiedliche Farbtinten besteht, wobei die Farben von Schwarz verschieden sind.

8. Tintenstrahlkopf gemäß Anspruch 1, der mindestens zwei Tintenausstoßabschnitte zum Ausstoß der gleichen Tintenfarbe aufweist, die jeweils eine Matrix von Ausstoßöffnungen aufweisen und so angeordnet sind, daß sie relativ zueinander in der Matrixrichtung, der Richtung rechtwinklig zu der Matrix oder beiden Richtungen ein ungeradzahliges Vielfaches der Hälfte eines Ausstoßöffnungsabstands der Ausstoßabschnitte verschoben sind.

9. Tintenstrahlkopf gemäß Anspruch 8, wobei die gleichen Farbtinten-Ausstoßabschnitte relativ zueinander um etwa die Hälfte des Ausstoßöffnungsabstands in der Matrixrichtung verschoben sind.

10. Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 9, der einen Kopfeinheitsaufbau aufweist, wobei Kopfchips, welche die einzelnen Ausstoßabschnitte ausbilden, in einem einstükkigen Rahmen angeordnet sind.

11. Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 9, der eine Vielzahl von Kopfeinheitsstrukturen mit Kopfchips aufweist, welche die einzelnen Ausstoßköpfe ausbilden, die in einem einstückigen Rahmen kombiniert sind.

12. Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 11, wobei die Ausstoßabschnitte ein Energieerzeugungselement zum Erzeugen von Energie aufweisen, um den Ausstoß von Tinte oder druckverbessernder Flüssigkeit zu bewirken.

13. Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 12, wobei der Flüssigkeitsausstoßabschnitt druckverbessernde Flüssigkeit bereitstellt, die einen kationischen Stoff einer Komponente mit niedrigem Molekulargewicht und eine Komponente mit hohem Molekulargewicht enthält und die Tinte einen anionischen Farbstoff enthält.

14. Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 12, wobei der Flüssigkeitsausstoßabschnitt druckverbessernde Flüssigkeit bereitstellt, die einen kationischen Stoff einer Komponente mit niedrigem Molekulargewicht und eine Komponente mit hohem Molekulargewicht enthält und die Tinte einen anionischen Farbstoff oder mindestens eine anionische Verbindung und ein Pigment enthält.

15. Tintenstrahlkopf gemäß Anspruch 1, wobei die Tinte eine Schwarztinte mit einem geringeren Eindringvermögen in ein Druckmedium als eine Farbtinte ist.

16. Tintenstrahl-Druckgerät zum Drucken auf einem Druckmedium durch Ausstoß von Tinte auf das Druckmedium, wobei das Gerät einen Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 15 aufweist.

17. Tintenstrahl-Druckgerät gemäß Anspruch 16, das aufweist:

- eine Hauptabtastvorrichtung zum wechselseitigen Abtasten des Tintenstrahlkopfs in Auswärtsrichtung und Rückführrichtung entlang einem Hauptabtastpfad über einem Druckmedium und
- eine Ausstoßsteuervorrichtung zum Steuern des Ausstoßes aus dem Tintenausstoßabschnitt und dem Flüssigkeitsausstoßabschnitt gemäß Druckdaten, wobei die Ausstoßsteuervorrichtung eingerichtet ist, die druckverbessernde Flüssigkeit zwischen Tinte auf dem Druckmedium in bezug auf eine Richtung senkrecht zu der Oberfläche des Druckmediums zu schichten.

18. Tintenstrahl-Druckgerät gemäß Anspruch 17, wobei die Ausstoßsteuervorrichtung eingerichtet ist, den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt in einer auswärts gerichteten Hauptabtastung, den Ausstoß von Tinte aus dem Tintenausstoßabschnitt, den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt in einer rückführenden Hauptabtastung und den Ausstoß von Tinte aus dem Tintenausstoßabschnitt zu bewirken.

19. Tintenstrahl-Druckgerät gemäß Anspruch 17, wobei die Ausstoßsteuervorrichtung eingerichtet ist, den Ausstoß von Tinte aus dem Tintenausstoßabschnitt in einer auswärts gerichteten Hauptabtastung zu bewirken, den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt, den Ausstoß von Tinte aus dem Tintenausstoßabschnitt in einer rückführenden Hauptabtastung und den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt.

20. Tintenstrahl-Druckgerät gemäß Anspruch 17, wobei die Ausstoßsteuervorrichtung eingerichtet ist, den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt in einer auswärts gerichteten Hauptabtastung zu bewirken, den Ausstoß von Tinte aus dem Tintenausstoßabschnitt, den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt in einer rückführenden Hauptabtastung, den Ausstoß von Tinte aus dem Tintenausstoßabschnitt und den Ausstoß von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt.

21. Tintenstrahl-Druckgerät, das eine Haupteinheit und einen Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 15 aufweist, der an der Haupteinheit abnehmbar montiert ist.

22. Tintenstrahl-Druckgerät gemäß Anspruch 21, wenn abhängig von Anspruch 10 oder 11, das eine Vorrichtung zur Unterscheidung einzelner Kopfeinheiten zur optimierten Steuerung aufweist.

23. Tintenstrahl-Druckgerät gemäß Anspruch 21 oder Anspruch 22, das ferner eine Drucksteuervorrichtung zum Steuern des Ausstoßes aus den Ausstoßabschnitten aufweist, um ein Bild auf einem Druckmedium so zu erzeugen, daß druckverbessernde Flüssigkeit, die aus dem Flüssigkeitsausstoßabschnitt ausgestoßen ist, zwischen Tinten zwischengeschichtet wird, die aus den Tintenausstoßabschnitten ausgestoßen sind.

24. Tintenstrahl-Druckgerät gemäß Anspruch 23, wobei die Drucksteuervorrichtung eingerichtet ist, zu bewirken, daß die die druckverbessernde Flüssigkeit zwischenschichtenden Tinten gleicher Farbe sind.

25. Tintenstrahl-Druckgerät gemäß Anspruch 23, wobei die Drucksteuervorrichtung eingerichtet ist, zu bewirken, daß die die druckverbessernde Flüssigkeit zwischenschichtenden Tinten unterschiedlicher Farbe sind.

26. Tintenstrahl-Druckgerät gemäß Anspruch 23, wobei die Drucksteuervorrichtung eingerichtet ist, zu bewirken, daß die die druckverbessernde Flüssigkeit zwischenschichtenden Tinten unterschiedliche Zusammensetzungen aufweisen.

27. Tintenstrahl-Druckgerät gemäß Anspruch 26, wobei eine der unterschiedlichen Zusammensetzungen eine lösungsmittelhaltige Komposition mit ausgezeichnetem Eindringvermögen ist, die augenblicklich in das Druckmedium eindringt, und die andere eine überdeckende, lösungsmittelhaltige Komposition ist, die allmählich in das Druckmedium eindringt.

28. Gerät gemäß einem der Ansprüche 21 bis 27, das ferner eine Hauptabtastvorrichtung zum Bewirken der Relativbewegung zwischen dem Tintenstrahlkopf und einem Druckmedium aufweist, um den Tintenstrahlkopf zu veranlassen, einen Hauptabtastpfad entlang dem Druckmedium abzutasten.

29. Tintenstrahl-Druckgerät gemäß einem der Ansprüche 23 bis 27, das ferner eine Hauptabtastvorrichtung zum Bewirken der Relativbewegung zwischen dem Tintenstrahlkopf und einem Druckmedium aufweist, um den Tintenstrahlkopf zu veranlassen, einen Hauptabtastpfad entlang dem Druckmedium abzutasten, wobei der Aufbau derart ist, daß bei Anwendung die druckverbessernde Flüssigkeit, die aus dem Flüssigkeitsausstoßabschnitt ausgestoßen wird, in einer Position angeordnet wird, die um ein halbes Bildelement in bezug auf ein Tintenbildelement auf dem Druckmedium in der Hauptabtastrichtung oder einer Nebenabtastrichtung verschoben ist.

30. Tintenstrahl-Druckgerät gemäß Anspruch 28 oder 29, wobei die Drucksteuervorrichtung in der Lage ist, den Einfachdurchlauf-Zweirichtungsdruck zu bewirken.

31. Tintenstrahl-Druckgerät gemäß Anspruch 28 oder 29, wobei die Drucksteuervorrichtung in der Lage ist, den einseitig gerichteten Einfachdurchlaufdruck zu bewirken.

32. Tintenstrahl-Druckgerät gemäß Anspruch 28 oder 29, wobei die Drucksteuervorrichtung in der Lage ist, den Zweifachdurchlauf-Zweirichtungsdruck zu bewirken.

33. Tintenstrahl-Druckgerät gemäß Anspruch 28 oder 29, wobei die Drucksteuervorrichtung in der Lage ist, den einseitig gerichteten Zweifachdurchlaufdruck zu bewirken.

34. Tintenstrahl-Druckgerät gemäß Anspruch 28 oder 29, wobei die Drucksteuervorrichtung in der Lage ist, den N-fachdurchlauf-Zweirichtungsdruck (wobei N eine positive Zahl ist) zu bewirken.

35. Tintenstrahl-Druckgerät gemäß Anspruch 28 oder 29, wobei die Drucksteuervorrichtung in der Lage ist, den einseitig gerichteten N-fachdurchlaufdruck (wobei N eine positive Zahl ist) zu bewirken.

36. Tintenstrahlkopf-Druckgerät gemäß Anspruch 17, 18, 19 oder 20, das einen Tintenstrahlkopf aufweist, wobei der erste Tintenausstoßabschnitt ein Schwarztinten-Ausstoßabschnitt ist und der zweite Tintenausstoßabschnitt eine Vielzahl von Ausstoßabschnitten unterschiedlicher Farbtinten aufweist und der Tintenstrahlkopf so in dem Gerät montiert ist, daß der erste Tintenausstoßabschnitt, der Flüssigkeitsausstoßabschnitt und der zweite Tintenausstoßabschnitt in dieser Reihenfolge entlang dem Hauptabtastpfad angeordnet sind.

37. Tintenstrahl-Druckgerät gemäß Anspruch 17, 18, 19 oder 20, das einen Tintenstrahlkopf mit einem ersten Tintenausstoßabschnitt und einem zweiten Tintenausstoßabschnitt, einem Flüssigkeitsausstoßabschnitt zum Ausstoß von druckverbessernder Flüssigkeit und einen dritten Ausstoßabschnitt zum Ausstoß von Tinten anders als Schwarztinte aufweist, wobei der erste Tintenausstoßabschnitt, der Flüssigkeitsausstoßabschnitt, der zweite Tintenausstoßabschnitt und der dritte Tintenausstoßabschnitt in dieser Reihenfolge entlang dem Hauptabtastpfad angeordnet sind und die Schwarztinte und andere Farbtinten derart sind, daß bei Verwendung das Eindringvermögen der Schwarztinte aus dem ersten Ausstoßabschnitt und dem zweiten Ausstoßabschnitt in ein Druckmedium geringer als das Eindringvermögen der Tinten aus dem dritten Ausstoßabschnitt ist, und wobei die Ausstoßsteuervorrichtung betreibbar ist, das Erzeugen eines Schwarzbilds auf dem Druckmedium durch Schwarztinte, die aus dem ersten Tintenausstoßabschnitt ausgestoßen ist, durch Flüssigkeit, die aus dem Flüssigkeitsausstoßabschnitt ausgestoßen ist, und durch Schwarztinte, die aus dem zweiten Tintenausstoßabschnitt in dieser Reihenfolge ausgestoßen ist, zu bewirken, um auf dem Druckmedium zu überlappen, wobei die Flüssigkeit, die eine Komponente enthält, welche ein Farbmaterial in Schwarztinte aus dem ersten Tintenausstoßabschnitt und dem zweiten Tintenausstoßabschnitt unlöslich macht oder koaguliert.

38. Tintenstrahl-Druckgerät gemäß Anspruch 17, 18, 19 oder 20, das einen Tintenstrahlkopf aufweist, bei dem entlang einer Hauptabtastrichtung ein erster Schwarztinten-Ausstoßabschnitt, der Ausstoßabschnitt für druckverbessernde Flüssigkeit, ein zweiter Schwarztinten-Ausstoßabschnitt, ein Cyantinten-Ausstoßabschnitt, ein Magentatinten-Ausstoßabschnitt und ein Gelbtinten-Ausstoßabschnitt angeordnet sind.

39. Tintenstrahl-Druckgerät gemäß Anspruch 17, 18, 19 oder 20, das einen Tintenstrahlkopf mit zwei oder mehr Tintenausstoßabschnitten mit Ausstoßöffnungsanordnungen zum Ausstoß der gleichen Farbtinte aufweist, die relativ zueinander um ein ungeradzahliges Vielfaches eines halben Ausstoßöffnungsabstands der Ausstoßabschnitte in einer Hauptabtastrichtung, einer Nebenabtastrichtung oder beiden Richtungen verschoben angeordnet sind.

40. Tintenstrahl-Druckgerät gemäß Anspruch 20, wenn abhängig von Anspruch 4, das ferner einen Anordnungsabschnitt aufweist, an dem der Tintenstrahlkopf abnehmbar montiert ist, wobei das Tintenstrahl-Druckgerät angepaßt ist, ein Schwarzbild auf einem Druckmedium durch Auftrag von Schwarztinte, die aus dem ersten Tintenausstoßabschnitt ausgestoßen ist, von Flüssigkeit, die aus dem Flüssigkeitsausstoßabschnitt ausgestoßen ist, von Schwarztinte, die aus dem zweiten Tintenausstoßabschnitt ausgestoßen ist, in dieser Reihenfolge auf dem Druckmedium durch deren überlappenden Auftrag zu erzeugen.

41. Tintenstrahl-Druckverfahren zum Herstellen eines Drukkerzeugnisses,
gekennzeichnet durch die Verwendung eines Tintenstrahlkopfs gemäß einem der Ansprüche 1 bis 15.

42. Tintenstrahl-Druckverfahren gemäß Anspruch 41, wobei das Verfahren die Schritte aufweist:

- Ausstoßen der druckverbessernden Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt auf das Druckmedium in einer Hauptabtastung in Auswärtsrichtung des Tintenstrahlkopfs in bezug auf ein Druckmedium, und
- Ausstoßen von Tinte aus dem Tintenausstoßabschnitt auf eine Weise, daß die Tinte die auf das Druckmedium ausgestoßene Flüssigkeit überlappt, und
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt in einer Hauptabtastung in Rückführrichtung in einer Weise, daß die Flüssigkeit die in der Hauptabtastung in Auswärtsrichtung ausgestoßene Tinte überlappt und der Ausstoß der Tinte aus dem Tintenausstoßabschnitt in einer Weise erfolgt, um die Flüssigkeit, die in der Abtastung in Rückführrichtung ausgestoßen ist, zu überlappen, so daß die druckverbessernde Flüssigkeit zwischen Tinten auf dem Druckmedium in bezug auf eine Richtung senkrecht zu der Oberfläche des Druckmediums zwischengeschichtet wird, um ein Bild zu erzeugen.

43. Tintenstrahl-Druckverfahren gemäß Anspruch 41, wobei das Verfahren die Schritte aufweist:

- Ausstoßen von Tinte aus dem Tintenausstoßabschnitt auf das Druckmedium in einer Hauptabtastung in Auswärtsrichtung des Tintenstrahlkopfs in bezug auf ein Druckmedium, und
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt, um die auf das Druckmedium ausgestoßene Tinte zu überlappen, und
- Ausstoßen von Tinte aus dem Tintenausstoßabschnitt in einer Hauptabtastung in Rückführrichtung, um die in der Abtastung in Auswärtsrichtung ausgestoßene Flüssigkeit zu überlappen, und
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt, um die in dieser Abtastung in Rückführrichtung ausgestoßene Tinte zu überlappen, so daß die druckverbessernde Flüssigkeit

zwischen Tinten auf dem Druckmedium in bezug auf eine Richtung senkrecht zu der Oberfläche des Druckmediums zwischengeschichtet wird.

44. Tintenstrahl-Druckverfahren gemäß Anspruch 41, wobei das Verfahren die Schritte aufweist:

- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt auf das Druckmedium in einer Hauptabtastung in Auswärtsrichtung des Tintenstrahlkopfs in bezug auf ein Druckmedium,
- Ausstoßen von Tinte aus dem Tintenausstoßabschnitt, um die das Druckmedium ausgestoßene Flüssigkeit zu überlappen, und
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt, um die Tinte, die auf die Flüssigkeit ausgestoßen ist, welche auf das Druckmedium ausgestoßen ist, zu überlappen,
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt in einer Abtastung in Rückführrichtung, um die Flüssigkeit, die zuletzt in der Abtastung in Auswärtsrichtung ausgestoßen ist, zu überlappen,
- Ausstoßen von Tinte aus dem Tintenausstoßabschnitt, um Flüssigkeit zu überlappen, die in dieser Abtastung in Rückführrichtung ausgestoßen ist, und
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt, um mit Tinte zu überlappen, die in dieser Abtastung in Rückführrichtung ausgestoßen ist, so daß die druckverbessernde Flüssigkeit zwischen Tinten auf dem Druckmedium in bezug auf die Richtung senkrecht zu der Oberfläche des Druckmediums zwischengeschichtet wird.

45. Tintenstrahl-Druckverfahren gemäß Anspruch 41, wobei das Verfahren die Schritte aufweist:

- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt auf das Druckmedium in einer Hauptabtastung des Tintenstrahlkopfs in bezug auf ein Druckmedium,
- Ausstoßen von Tinte aus dem Tintenausstoßabschnitt, um die Flüssigkeit zu überlappen, die auf das Druckmedium ausgestoßen ist, und
- Ausstoßen von druckverbessernder Flüssigkeit aus dem Flüssigkeitsausstoßabschnitt, um Tinte zu überlappen, die auf die Flüssigkeit ausgestoßen ist, welche auf das Druckmedium ausgestoßen ist, so daß die Tinte zwischen den Flüssigkeiten auf dem Druckmedium in bezug auf eine Richtung senkrecht zu der Oberfläche des Druckmediums zwischengeschichtet ist.

46. Tintenstrahlpatrone, die einen Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 15 und einen Tintenbehälter aufweist, der an dem Tintenstrahlkopf abnehmbar angeordnet ist.

47. Druckerzeugnis, das ein Druckmedium mit einem durch Tinte darauf erzeugten Bild aufweist, wobei die Tinte durch einen Tintenstrahlkopf gemäß einem der Ansprüche 1 bis 15 ausgestoßen ist und einer druckverbessernden Flüssigkeit, um einen Farbstoff oder ein Pigment in einer Tinte unlöslich zu machen oder zu aggregieren, wobei die druckverbessernde Flüssigkeit zwischen mindestens einer Reihe von Farbtinten auf dem Druckmedium zwischengeschichtet ist.

48. Druckerzeugnis gemäß Anspruch 47, wobei die druckverbessernde Flüssigkeit in einer Position angeordnet wird, die um ein halbes Bildelement in bezug auf ein Tintenbildelement auf dem Druckmedium in einer Hauptabtastrichtung, einer Nebenabtastrichtung oder beiden Richtungen verschoben ist.

49. Druckerzeugnis gemäß Anspruch 47 oder Anspruch 48, wobei die Farbtinten gleicher Farbe sind.

50. Druckerzeugnis gemäß Anspruch 47 oder Anspruch 48,
dadurch gekennzeichnet, daß die Farbtinten unterschiedlicher Farbe sind.

51. Druckerzeugnis gemäß Anspruch 47, wobei eine Komponentenmenge der druckverbessernden Flüssigkeit, die in der Mitte der Zwischenschicht vorliegt, größer als die Menge der einzelnen Tintenkomponenten ist, welche die druckverbessernde Flüssigkeit zwischenschichten.

52. Steuervorrichtung für ein Tintenstrahl-Druckgerät zum Drucken auf ein Druckmedium unter Verwendung eines Tintenstrahlkopfs gemäß einem der Ansprüche 1 bis 15, wobei die Steuervorrichtung aufweist:

eine Ausstoßsteuervorrichtung, um den Tintenausstoß aus dem Tintenausstoßabschnitt zu bewirken, dann

den Flüssigkeitsausstoß aus dem Flüssigkeitsausstoßabschnitt zu bewirken und dann den Ausstoß mehrerer Tinten aus einem Ausstoßabschnitt zu bewirken, so daß die druckverbessernde Flüssigkeit zwischen Tinte auf dem Druckmedium in bezug auf eine Richtung senkrecht zu der Oberfläche des Druckmediums zwischengeschichtet wird.

Revendications

1. Tête à jet d'encre, comprenant :

une première partie (BK1) de décharge d'encre pour décharger une encre ;
une partie (S) de décharge de liquide pour décharger un liquide contenant au moins un liquide pour améliorer l'impression afin de rendre insoluble ou d'agréger un colorant ou un pigment dans une encre ; et
une deuxième partie (BK2) de décharge d'encre pour décharger de l'encre, **caractérisé en ce que** les parties de décharge de la première encre, de liquide et de la deuxième encre sont agencées dans cet ordre dans une direction prédéterminée.

2. Tête à jet d'encre selon la revendication 1, dans laquelle ladite première partie (BK1) de décharge d'encre et ladite deuxième partie (BK2) de décharge d'encre contiennent une encre de la même couleur.

3. Tête à jet d'encre selon la revendication 2, dans laquelle lesdites première et deuxième encres sont des encres noires.

4. Tête à jet d'encre selon la revendication 2, dans laquelle lesdites première et deuxième encres sont des encres noires et la tête comprend en outre une troisième partie (2103) de décharge d'encre pour décharger des encres autres que l'encre noire, lesdites parties de décharge de la première encre, de liquide, de la deuxième encre et de la troisième encre étant agencées dans cet ordre et ladite encre noire et lesdites autres encres étant telles que, lors de l'utilisation de la tête pour imprimer sur un support d'impression, la pénétration de l'encre noire en provenance desdites première et deuxième parties de décharge dans le support d'impression est inférieure à celle de l'encre en provennace de ladite troisième partie de décharge et le liquide contient un composant qui insolubilise ou coagule un matériau colorant dans l'encre noire en provenance desdites première et deuxième parties de décharge.

5. Tête à jet d'encre selon la revendication 2, dans laquelle ladite première partie de décharge d'encre est une première partie (2125-BK) de décharge d'encre noire, ladite deuxième partie (2105) de décharge d'encre est une deuxième partie de décharge d'encre noire, et la tête comprend en outre une partie (2125-C) de décharge d'encre cyan, une partie (2125-M) de décharge d'encre magenta, et une partie (2125-Y) de décharge d'encre jaune, les parties de décharge étant agencées dans cet ordre.

6. Tête à jet d'encre selon la revendication 1, dans laquelle ladite première partie (2125) de décharge d'encre et ladite deuxième partie (2105) de décharge d'encre contiennent des encres de différentes couleurs.

7. Tête à jet d'encre selon la revendication 6, dans laquelle ladite première encre est une encre noire et ladite deuxième partie de décharge d'encre comprend un agencement intégré consistant en une pluralité de différentes parties de décharge d'encre en couleurs, lesdites couleurs étant différentes du noir.

8. Tête à jet d'encre selon la revendication 1, comprenant au moins deux parties de décharge d'encre pour décharger de l'encre de même couleur, comportant chacune un réseau de sorties de décharge et étant agencées de manière à être décalées l'une par rapport à l'autre, dans la direction du réseau, la direction perpendiculaire au réseau ou les deux directions, d'un nombre impair de fois 1/2 pas de sortie de décharge desdites parties de décharge.

9. Tête à jet d'encre selon la revendication 8, dans laquelle lesdites parties de décharge d'encre de même couleur sont décalées les unes par rapport aux autres environ d'un autre 1/2 pas de sortie de décharge dans la direction du réseau.

10. Tête à jet d'encre selon l'une quelconque des revendications 1 à 9, comportant une structure d'unité formant tête dans laquelle des puces de tête constituant lesdites parties individuelles de décharge sont disposées dans un cadre de type intégral.

11. Tête à jet d'encre selon l'une quelconque des revendications 1 à 9, comportant une pluralité de structures d'unité formant tête comportant des puces de tête constituant lesdites têtes de décharge individuelles combinées dans un cadre de type intégral.

12. Tête à jet d'encre selon l'une quelconque des revendications 1 à 11, dans laquelle lesdites parties de décharge comportent un élément de génération d'énergie pour générer de l'énergie afin de provoquer une décharge d'encre ou d'un liquide pour améliorer l'impression.

13. Tête à jet d'encre selon l'une quelconque des revendications 1 à 12, dans laquelle ladite partie de décharge de liquide fournit un liquide pour améliorer l'impression contenant une substance cationique d'un composant de faible poids moléculaire et d'un composant de fort poids moléculaire, et ladite encre contient un colorant anionique.

14. Tête à jet d'encre selon l'une quelconque des revendications 1 à 12, dans laquelle ladite partie de décharge de liquide fournit un liquide pour améliorer l'impression contenant une substance cationique d'un composant de faible poids moléculaire et d'un composant de fort poids moléculaire, et ladite encre contient un colorant anionique ou au moins un composé anionique et un pigment.

15. Tête à jet d'encre selon la revendication 1, dans laquelle ladite encre est une encre noire ayant une pénétration dans un support d'impression inférieure à celle d'une encre colorée.

16. Appareil d'impression à jet d'encre pour imprimer sur un support d'impression par décharge d'encre sur le support d'impression, l'appareil comprenant une tête à jet d'encre selon l'une quelconque des revendications 1 à 15.

17. Appareil d'impression à jet d'encre selon la revendication 16, comprenant :

un moyen de balayage principal pour balayer selon un mouvement de va et vient ladite tête à jet d'encre vers l'extérieur et en retour le long d'un trajet de balayage principal sur un support d'impression ; et
un moyen de commande de décharge pour commander une décharge à partir desdites parties de décharge d'encre et de liquide en fonction de données à imprimer, le moyen de commande de décharge étant agencé de façon à ce qu'un liquide pour améliorer l'impression sont pris en sandwich entre l'encre sur le support d'impression par rapport à une direction perpendiculaire à la surface du support d'impression.

18. Appareil d'impression à jet d'encre selon la revendication 17, dans lequel ledit moyen de commande de décharge est agencé pour provoquer une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide lors d'un balayage principal vers l'extérieur, une décharge d'encre à partir de ladite partie de décharge d'encre, une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide lors d'un balayage principal en retour, et une décharge d'encre à partir de ladite partie de décharge d'encre.

19. Appareil d'impression à jet d'encre selon la revendication 17, dans lequel ledit moyen de commande de décharge est agencé pour provoquer une décharge d'encre à partir de ladite partie de décharge d'encre lors d'un balayage principal vers l'extérieur, une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide, une décharge d'encre à partir de ladite partie de décharge d'encre lors d'un balayage principal en retour, et une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide.

20. Appareil d'impression à jet d'encre selon la revendication 17, dans lequel ledit moyen de commande de décharge est agencé pour provoquer une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide lors d'un balayage principal vers l'extérieur, une décharge d'encre à partir de ladite partie de décharge d'encre, une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide lors d'un balayage principal en retour, une décharge d'encre à partir de ladite partie de décharge d'encre, et une décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide.

21. Appareil d'impression à jet d'encre comprenant une unité principale et une tête à jet d'encre selon l'une quelconque des revendications 1 à 15, montée de manière amovible sur l'unité principale.

22. Appareil d'impression à jet d'encre selon la revendication 21 lorsqu'elle dépend de la revendication 10 ou 11, comportant un moyen pour identifier des unités individuelles formant tête pour une commande optimisée.

23. Appareil d'impression à jet d'encre selon la revendication 21 ou la revendication 22, comprenant en outre un moyen

de commande d'impression pour commander une décharge à partir desdites parties de décharge pour former une image sur un support d'impression de telle sorte qu'un liquide pour améliorer l'impression, déchargé à partir de ladite partie de décharge de liquide, est pris en sandwich entre des encres déchargées à partir desdites parties de décharge d'encre.

24. Appareil d'impression à jet d'encre selon la revendication 23, dans lequel ledit moyen de commande d'impression est agencé pour conduire lesdites encres prenant en sandwich ledit liquide pour améliorer l'impression, à être de la même couleur.

25. Appareil d'impression à jet d'encre selon la revendication 23, dans lequel ledit moyen de commande d'impression est agencé pour conduire lesdites encres prenant en sandwich ledit liquide pour améliorer l'impression, à être de couleurs différentes.

26. Appareil d'impression à jet d'encre selon la revendication 23, dans lequel ledit moyen de commande d'impression est agencé pour conduire lesdites encres prenant en sandwich ledit liquide pour améliorer l'impression, à avoir des compositions différentes.

27. Appareil d'impression à jet d'encre selon la revendication 26, dans lequel l'une desdites compositions différentes est une composition de solvant du type à super pénétration, pénétrant en un instant dans le support d'impression, et l'autre est une composition de solvant du type à recouvrement, pénétrant graduellement dans le support d'impression.

28. Appareil selon l'une quelconque des revendications 21 à 27, comprenant en outre un moyen de balayage principal pour effectuer un mouvement relatif entre ladite tête à jet d'encre et un support d'impression pour conduire la tête à jet d'encre à balayer un trajet de balayage principal sur le support d'impression.

29. Appareil d'impression à jet d'encre selon l'une quelconque des revendications 23 à 27, comprenant en outre un moyen de balayage principal pour effectuer un mouvement relatif entre ladite tête à jet d'encre et un support d'impression pour conduire la tête à jet d'encre à balayer un trajet de balayage principal sur le support d'impression, l'agencement étant tel que, lors de l'utilisation, un liquide pour améliorer l'impression, déchargé à partir de ladite partie de décharge de liquide, est situé au niveau d'une position décalée d'1/2 élément d'image par rapport à un élément de représentation d'encre sur le support d'impression dans la direction de balayage principal ou une direction de balayage secondaire.

30. Appareil d'impression à jet d'encre selon la revendication 28 ou 29, dans lequel ledit moyen de commande d'impression est capable de provoquer une impression bidirectionnelle à 1 passage.

31. Appareil d'impression à jet d'encre selon la revendication 28 ou 29, dans lequel ledit moyen de commande d'impression est capable de provoquer une impression unidirectionnelle à 1 passage.

32. Appareil d'impression à jet d'encre selon la revendication 28 ou 29, dans lequel ledit moyen de commande d'impression est capable de provoquer une impression bidirectionnelle à 2 passages.

33. Appareil d'impression à jet d'encre selon la revendication 28 ou 29, dans lequel ledit moyen de commande d'impression est capable de provoquer une impression unidirectionnelle à 2 passages.

34. Appareil d'impression à jet d'encre selon la revendication 28 ou 29, dans lequel ledit moyen de commande d'impression est capable de provoquer une impression bidirectionnelle à N (N étant un nombre positif) passages.

35. Appareil d'impression à jet d'encre selon la revendication 28 ou 29, dans lequel ledit moyen de commande d'impression est capable de provoquer une impression unidirectionnelle à N (N étant un nombre positif) passages.

36. Appareil d'impression à tête à jet d'encre selon la revendication 17, 18, 19 ou 20, comprenant une tête à jet d'encre dans laquelle ladite première partie de décharge d'encre est une partie de décharge d'encre noire, et ladite deuxième partie de décharge d'encre comprend une pluralité de parties de décharge d'encre de couleurs différentes et la tête à jet d'encre est montée sur l'appareil de telle sorte que la première partie de décharge d'encre, la partie de décharge de liquide et la deuxième partie de décharge d'encre sont agencées dans cet ordre le long du trajet de balayage principal.

37. Appareil d'impression à jet d'encre selon la revendication 17, 18, 19 ou 20, comprenant une tête à jet d'encre comportant une première et une deuxième parties de décharge d'encre noire, une partie de décharge de liquide pour décharger un liquide pour améliorer l'impression et une troisième partie de décharge pour décharger des encres autres que des encres noires, lesdites parties de décharge de première encre, de liquide, de deuxième encre et de troisième encre étant agencées dans cet ordre le long du trajet de balayage principal et l'encre noire et les encres des autres couleurs étant telles que, lors de l'utilisation, la pénétration de l'encre noire à partir desdites première et deuxième parties de décharge dans le support d'impression est inférieure à celle des encres à partir de ladite troisième partie de décharge d'encre, et dans lequel ledit moyen de commande de décharge peut fonctionner pour conduire une image noire à être formée sur le support d'impression par de l'encre noire déchargée à partir de ladite première partie de décharge d'encre, du liquide déchargé à partir de ladite partie de décharge de liquide, et de l'encre noire déchargée à partir de la deuxième partie de décharge d'encre, dans cet ordre, de manière superposée sur le support d'impression, le liquide contenant un composant qui insolubilise ou coagule un matériau colorant dans l'encre noire entre lesdites première et deuxième parties de décharge d'encre.

38. Appareil d'impression à jet d'encre selon la revendication 17, 18, 19 ou 20, comprenant une tête à jet d'encre comportant, agencées le long d'une direction de balayage principal, une première partie de décharge d'encre noire, ladite partie de décharge de liquide pour améliorer l'impression, une deuxième partie de décharge d'encre noire, une partie de décharge d'encre cyan, une partie de décharge d'encre magenta et une partie de décharge d'encre jaune.

39. Appareil d'impression à jet d'encre selon la revendication 17, 18, 19 ou 20, comprenant une tête à jet d'encre comportant deux parties de décharge d'encre ou davantage, comportant des réseaux de sortie de décharge pour décharger de l'encre de même couleur, disposés de manière décalée les uns par rapport aux autres d'un nombre impair de 1/2 pas de sortie de décharge desdites parties de décharge dans une direction de balayage principal, une direction de balayage secondaire ou les deux.

40. Appareil d'impression à jet d'encre selon la revendication 20 lorsqu'elle dépend de la revendication 4, comprenant en outre une section de montage pour le montage de manière amovible de la tête à jet d'encre, dans lequel l'appareil d'impression à jet d'encre est apte à former une image noire sur un support d'impression par application d'encre noire déchargée à partir de ladite première partie de décharge d'encre, du liquide déchargé à partir de ladite partie de décharge de liquide, de l'encre noire déchargée à partir de ladite deuxième partie de décharge d'encre, dans cet ordre, sur le support d'impression, de manière superposée.

41. Procédé d'impression à jet d'encre pour produire un produit imprimé, **caractérisé par** l'utilisation d'une tête à jet d'encre selon l'une quelconque des revendications 1 à 15.

42. Procédé d'impression à jet d'encre selon la revendication 41, dans lequel ledit procédé comprend les étapes :

lors d'un balayage principal vers l'extérieur de la tête à jet d'encre par rapport à un support d'impression, de décharge dudit liquide pour améliorer l'impression, à partir de ladite partie de décharge de liquide, sur ledit support d'impression, et de décharge d'encre à partir de ladite partie de décharge d'encre de telle sorte que l'encre est superposée audit liquide déchargé sur ledit support d'impression ; et
lors d'un balayage principal en retour, de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide, de telle sorte que le liquide est superposé à ladite encre déchargée lors dudit balayage principal vers l'extérieur, et de décharge de ladite encre à partir de ladite partie de décharge d'encre de manière superposée audit liquide déchargé lors du balayage en retour, de telle sorte que ledit liquide pour améliorer l'impression est pris en sandwich entre des encres sur le support d'impression par rapport à une direction perpendiculaire à la surface du support d'impression pour former une image.

43. Procédé d'impression à jet d'encre selon la revendication 41, dans lequel ledit procédé comprend les étapes :

lors d'un balayage principal vers l'extérieur de la tête à jet d'encre par rapport à un support d'impression, de décharge d'encre à partir de ladite partie de décharge d'encre sur ledit support d'impression, et de décharge de liquide pour améliorer l'impression, à partir de ladite partie de décharge de liquide, de manière superposée à ladite encre déchargée sur ledit support d'impression ; et
lors d'un balayage principal en retour, de décharge d'encre à partir de ladite partie de décharge d'encre de manière superposée audit liquide déchargé au cours dudit balayage vers l'extérieur, et de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide de manière superposée à ladite

encre déchargée lors de ce balayage en retour, de telle sorte que ledit liquide pour améliorer l'impression est pris en sandwich entre des encres sur le support d'impression par rapport à une direction perpendiculaire à la surface du support d'impression.

44. Procédé d'impression à jet d'encre selon la revendication 41, dans lequel ledit procédé comprend les étapes :

lors d'un balayage principal vers l'extérieur de la tête à jet d'encre par rapport à un support d'impression, de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide sur ledit support d'impression, de décharge d'encre à partir de ladite partie de décharge d'encre de manière superposée audit liquide déchargé sur ledit support d'impression, et de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide de manière superposée à ladite encre déchargée sur ledit liquide qui est déchargé sur ledit support d'impression ; et
lors d'un balayage principal en retour, de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide de manière superposée audit liquide déchargé en dernier au cours dudit balayage vers l'extérieur, de décharge d'encre à partir de ladite partie de décharge d'encre de manière superposée audit liquide déchargé au cours de ce balayage en retour, et de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide de manière superposée à l'encre déchargée au cours de ce balayage en retour, de telle sorte que ledit liquide pour améliorer l'impression est pris en sandwich entre des encres sur le support d'impression par rapport à une direction perpendiculaire à la surface du support d'impression.

45. Procédé d'impression à jet d'encre selon la revendication 41, dans lequel ledit procédé comprend les étapes :

lors d'un balayage principal de ladite tête à jet d'encre par rapport à un support d'impression, de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide sur ledit support d'impression, de décharge d'encre à partir de ladite partie de décharge d'encre de manière superposée audit liquide déchargé sur ledit support d'impression ; et de décharge de liquide pour améliorer l'impression à partir de ladite partie de décharge de liquide de manière superposée à ladite encre déchargée sur ledit liquide qui est déchargé sur ledit support d'impression de telle sorte que ladite encre est prise en sandwich entre lesdits liquides sur le support d'impression par rapport à une direction perpendiculaire à la surface du support d'impression.

46. Cartouche à jet d'encre comprenant une tête à jet d'encre selon l'une quelconque des revendications 1 à 15 et un réservoir d'encre disposé de manière amovible sur ladite tête à jet d'encre.

47. Produit imprimé comprenant un support d'impression sur lequel est formée une image par de l'encre obtenue à partir d'une tête à jet d'encre selon l'une quelconque des revendications 1 à 15, et un liquide pour améliorer l'impression pour rendre insoluble ou agréger un colorant ou un pigment dans une encre, dans lequel ledit liquide pour améliorer l'impression est pris en sandwich entre au moins une série d'encres colorées sur le support d'impression.

48. Produit imprimé selon la revendication 47, dans lequel ledit liquide pour améliorer l'impression est disposé dans une position décalée d'1/2 élément d'image par rapport à un élément de représentation d'encre sur le support d'impression dans une direction de balayage principal, une direction de balayage secondaire ou les deux.

49. Produit imprimé selon la revendication 47 ou la revendication 48, dans lequel lesdites encres colorées sont de la même couleur.

50. Produit imprimé selon la revendication 47 ou la revendication 48, **caractérisé en ce que** lesdites encres colorées sont de différentes couleurs.

51. Produit imprimé selon la revendication 47, dans lequel la quantité de composant dudit liquide pour améliorer l'impression présent au centre du sandwich est supérieure aux quantités de composants individuels d'encres prenant en sandwich ledit liquide pour améliorer l'impression.

52. Dispositif de commande pour un appareil d'impression à jet d'encre pour imprimer sur un support d'impression en utilisant une tête à jet d'encre selon l'une quelconque des revendications 1 à 15, le dispositif de commande comprenant :

un moyen de commande de décharge pour provoquer une décharge d'encre à partir de la partie de décharge d'encre, puis pour provoquer une décharge de liquide à partir de ladite partie de décharge de liquide, puis pour provoquer une décharge de davantage d'encre à partir d'une partie de décharge, de telle sorte que le liquide pour améliorer l'impression est pris en sandwich entre l'encre sur le support d'impression par rapport à une direction perpendiculaire à la surface du support d'impression.

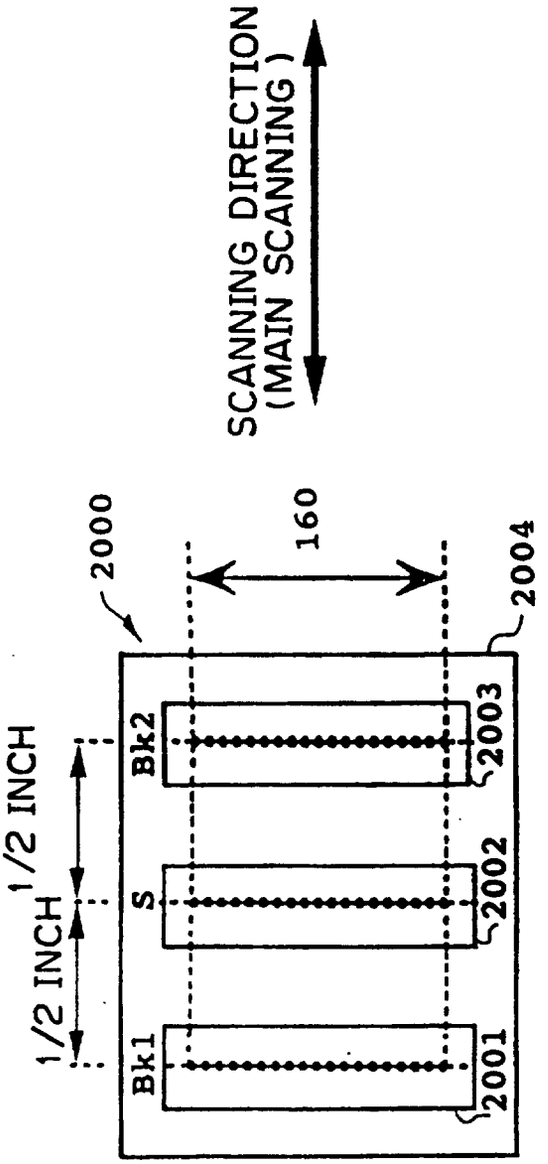

SCANNING DIRECTION
(MAIN SCANNING)
2000
160
2004
1/2 INCH
1/2 INCH
Bk2
S
Bk1
2003
2002
2001

FIG. 1

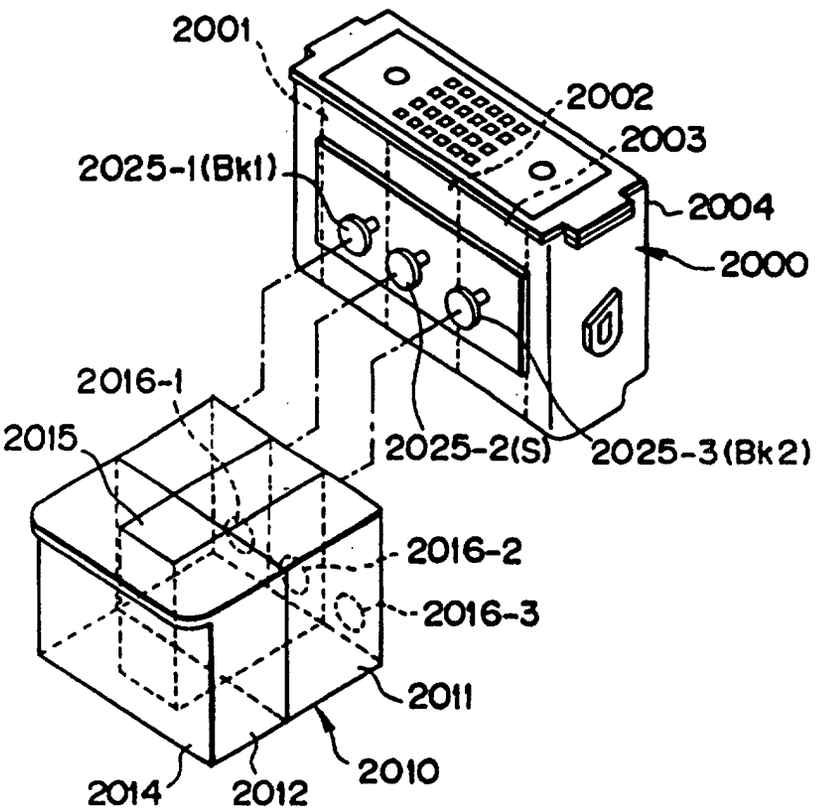

2001
2002
2003
2025-1(Bk1)
2004
2000
2016-1
2015
2025-2(S)
2025-3(Bk2)
2016-2
2016-3
2011
2010
2014
2012

FIG.2

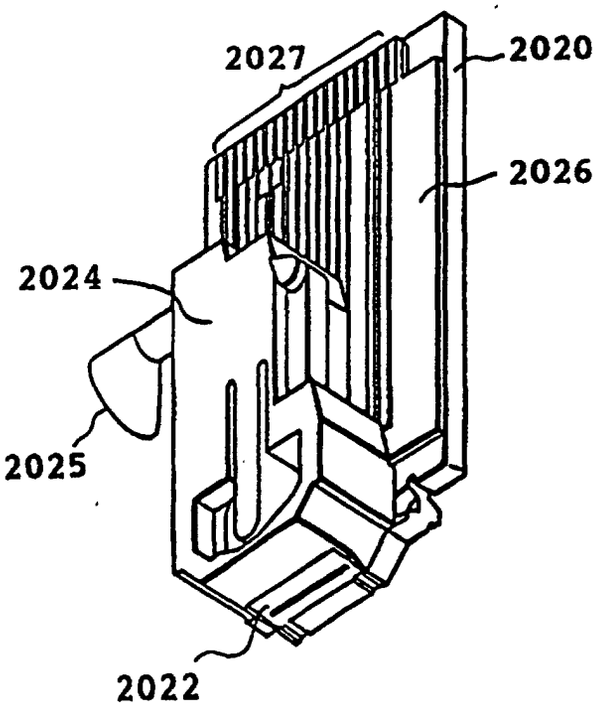


FIG.3

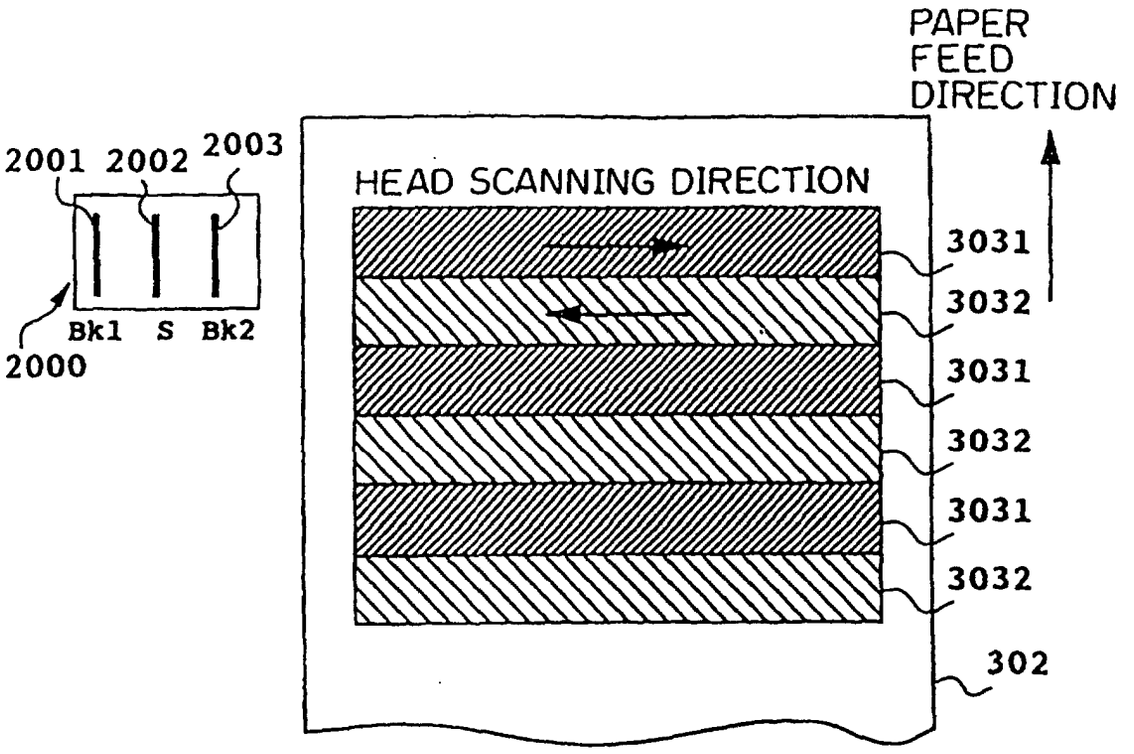


FIG.4A

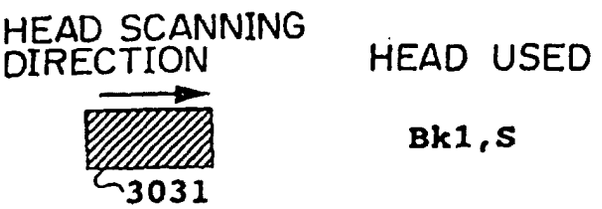


FIG.4B

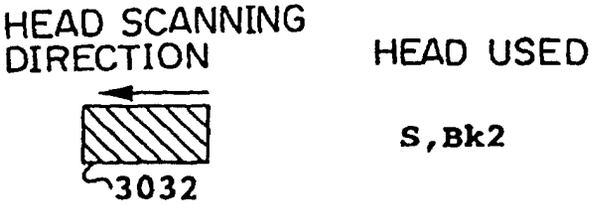


FIG.4C

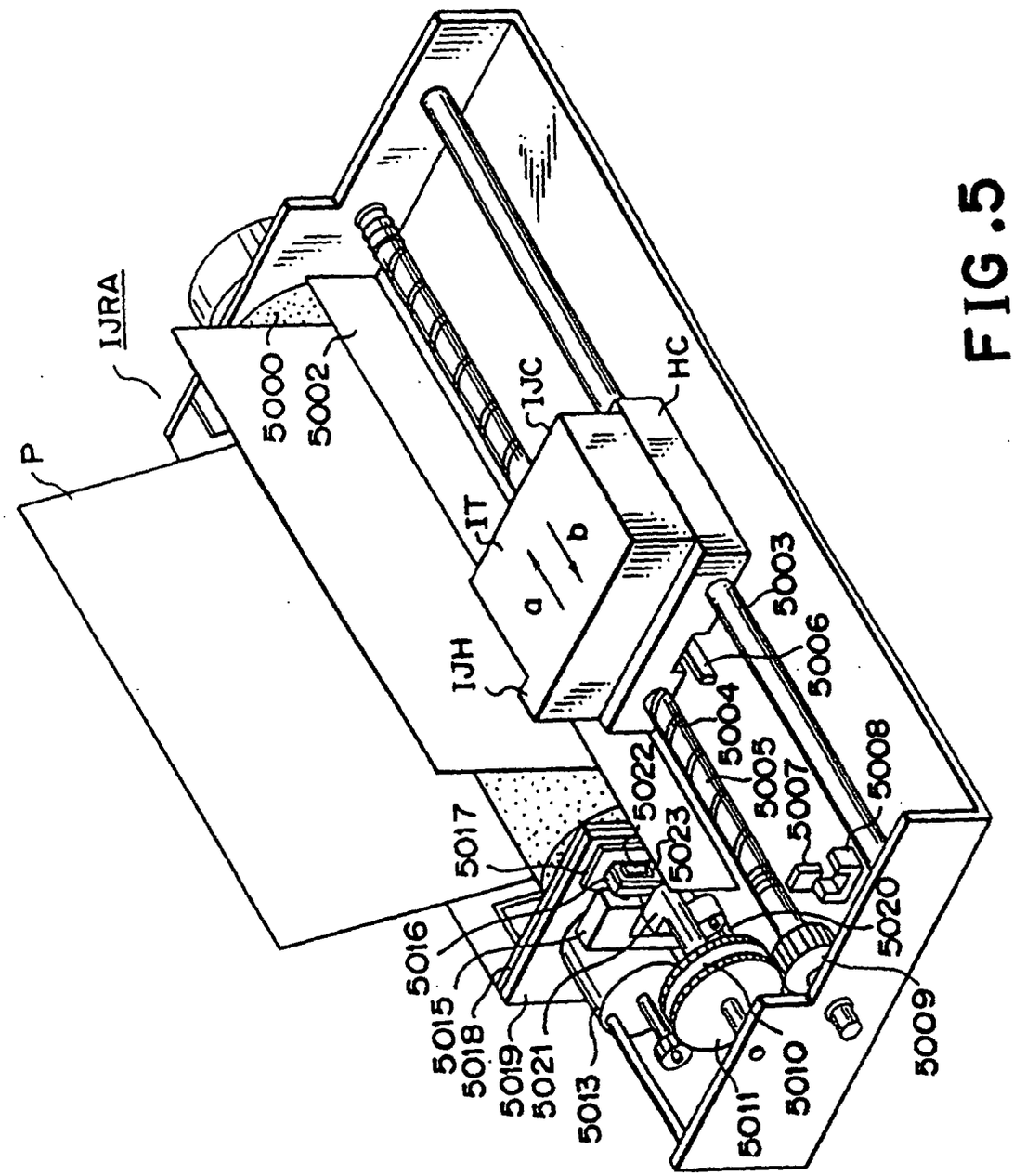

IJRA
P
5000
5002
IJC
HC
IT
a
b
IJH
5003
5006
5004
5005
5007
5008
5022
5023
5017
5016
5015
5018
5019
5021
5013
5011
5010
5020
5009

FIG.5

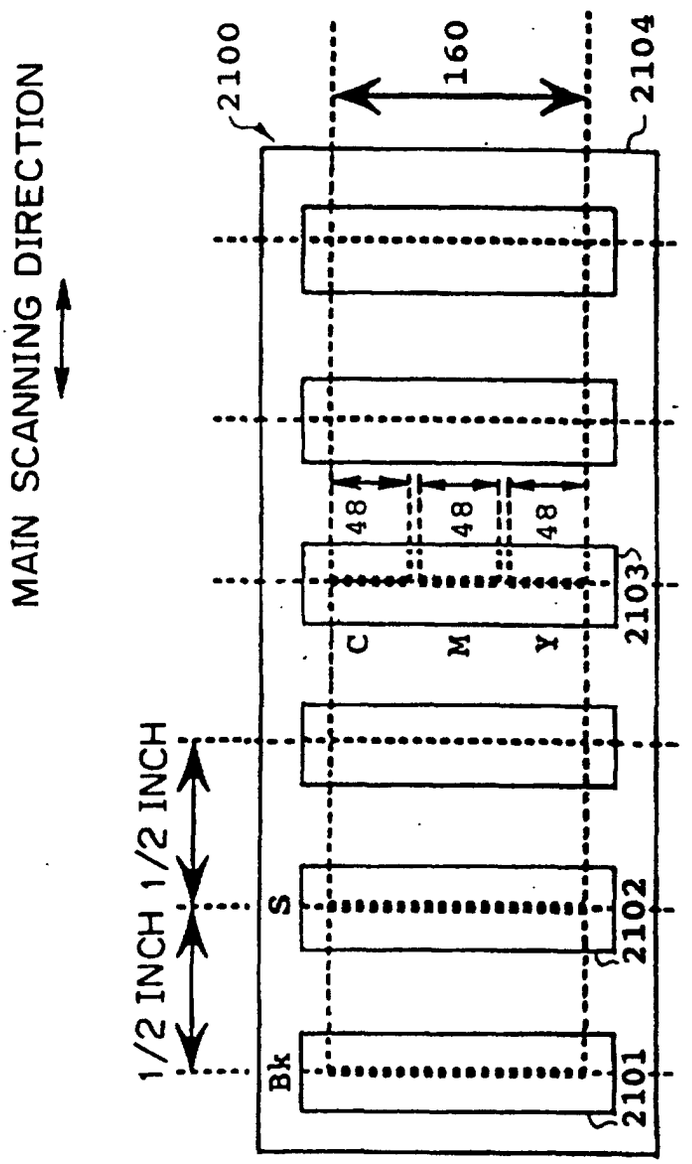

MAIN SCANNING DIRECTION
2100
160
2104
48
48
48
C
M
Y
2103
1/2 INCH
1/2 INCH
S
2102
Bk
2101

FIG.6

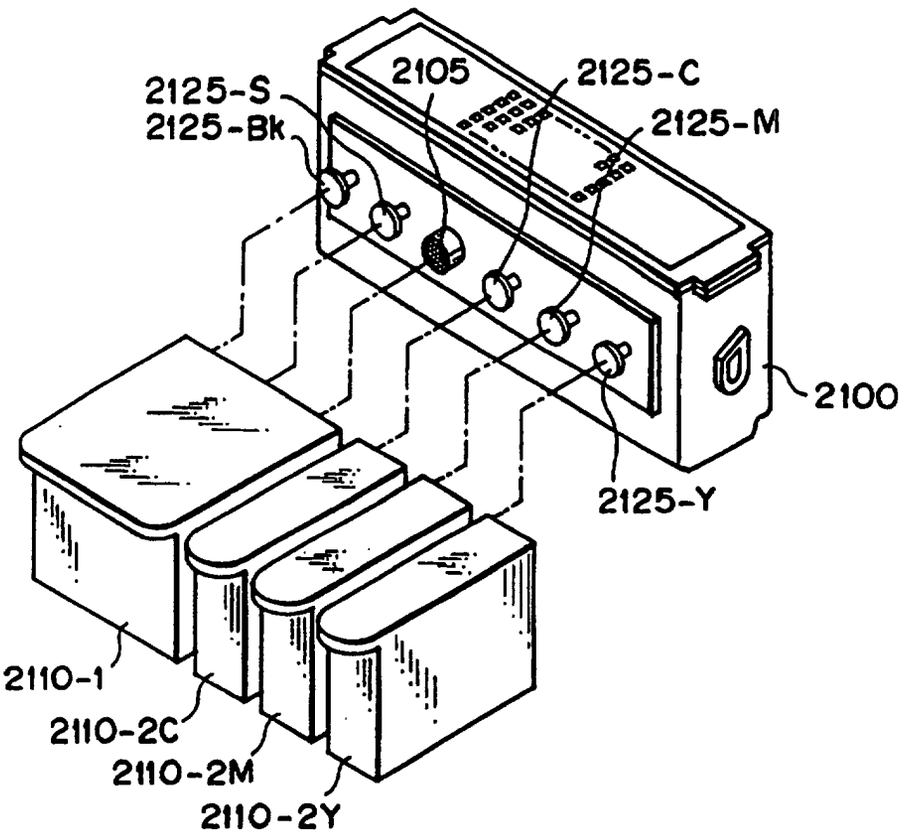

2125-S
2125-Bk
2105
2125-C
2125-M
2100
2125-Y
2110-1
2110-2C
2110-2M
2110-2Y

FIG.7

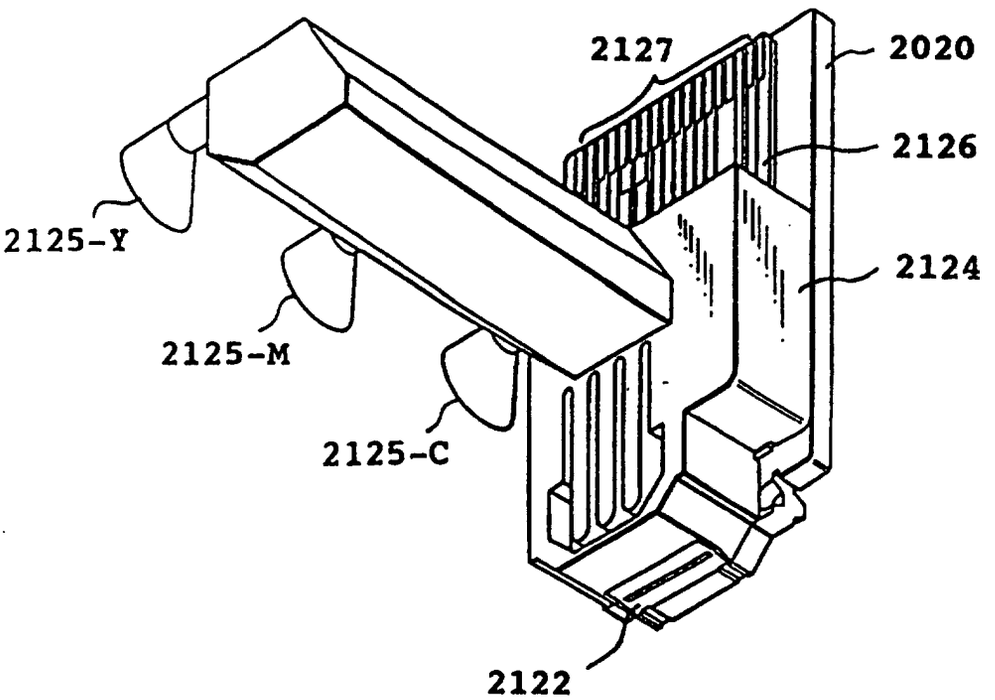


FIG.8

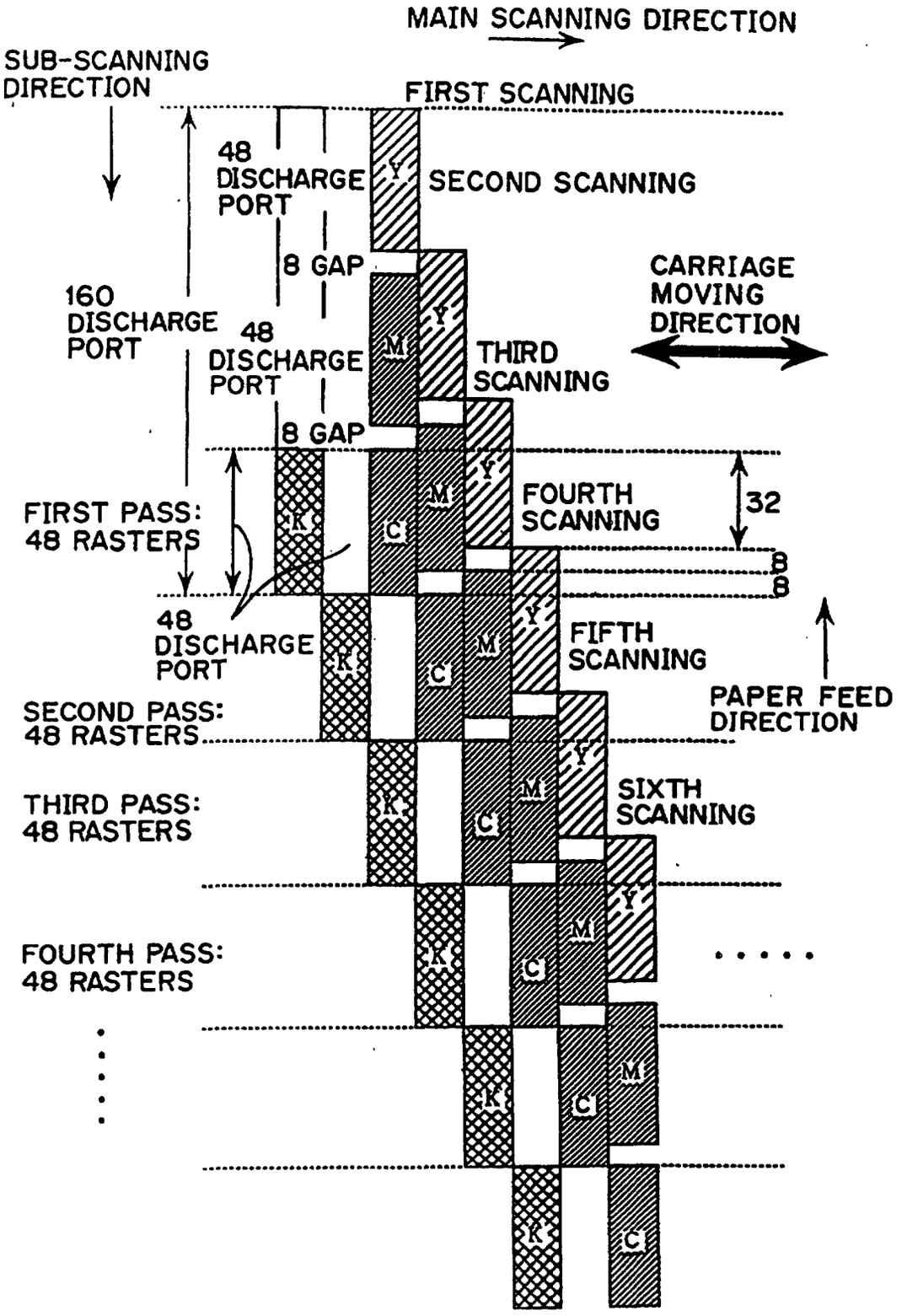

MAIN SCANNING DIRECTION
SUB-SCANNING DIRECTION
FIRST SCANNING
48 DISCHARGE PORT
SECOND SCANNING
8 GAP
CARRIAGE MOVING DIRECTION
160 DISCHARGE PORT
48 DISCHARGE PORT
THIRD SCANNING
8 GAP
FOURTH SCANNING
32
8
8
FIRST PASS: 48 RASTERS
48 DISCHARGE PORT
FIFTH SCANNING
PAPER FEED DIRECTION
SECOND PASS: 48 RASTERS
THIRD PASS: 48 RASTERS
SIXTH SCANNING
FOURTH PASS: 48 RASTERS
Y
M
C
K

FIG.9

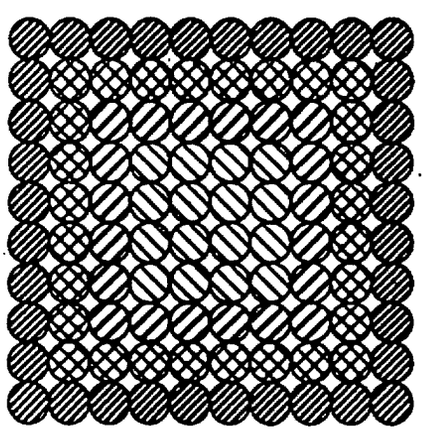


FIG.10A

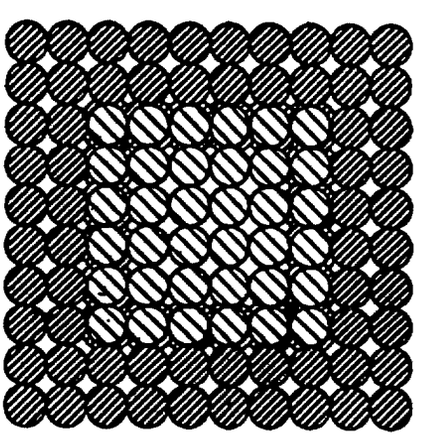


FIG.10B

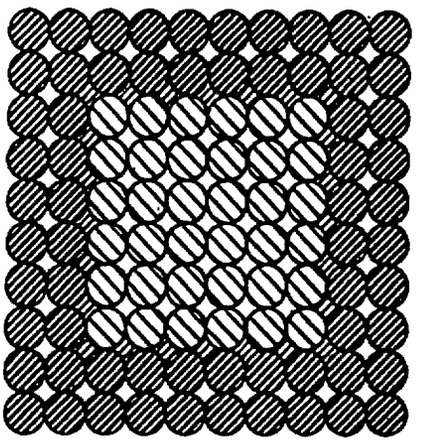


FIG.10C

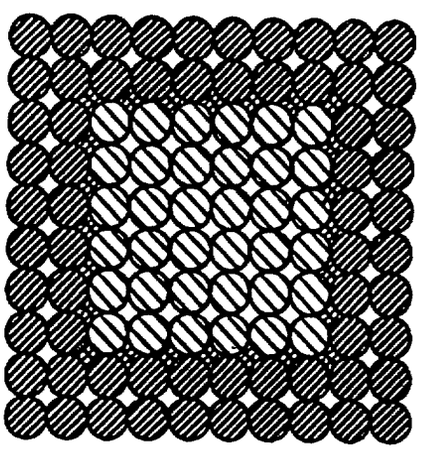


FIG.10D

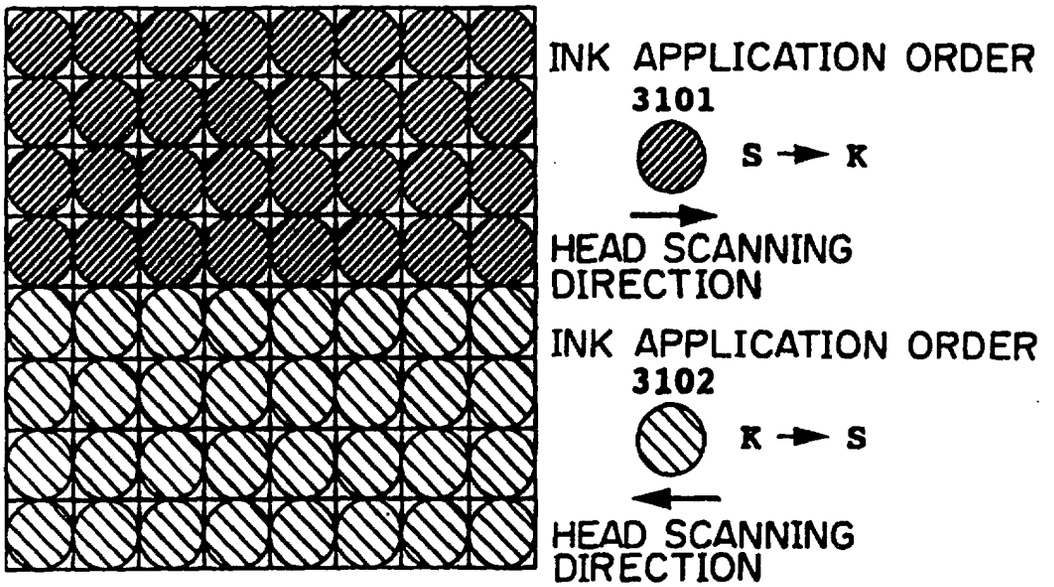


FIG. 11A

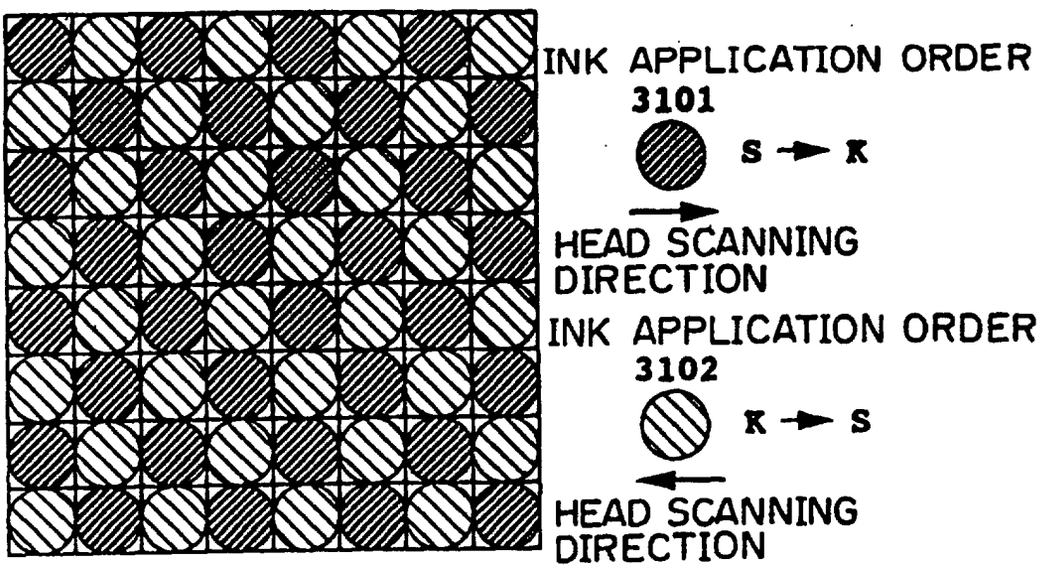


FIG. 11B

FIG.12A

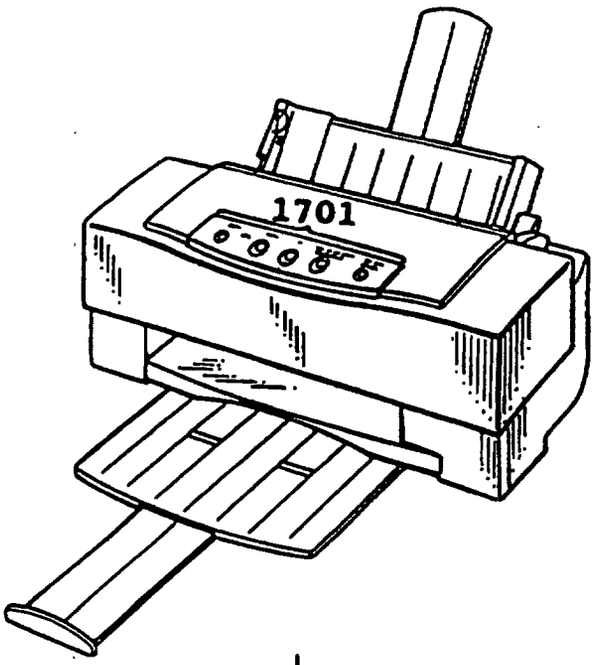
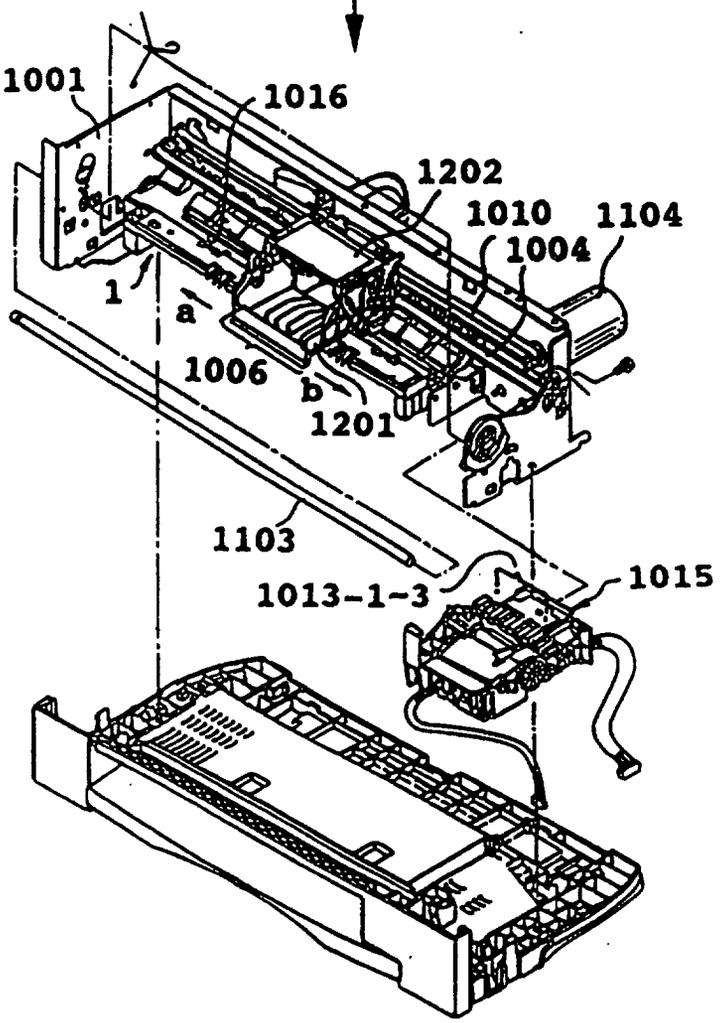


FIG.12B



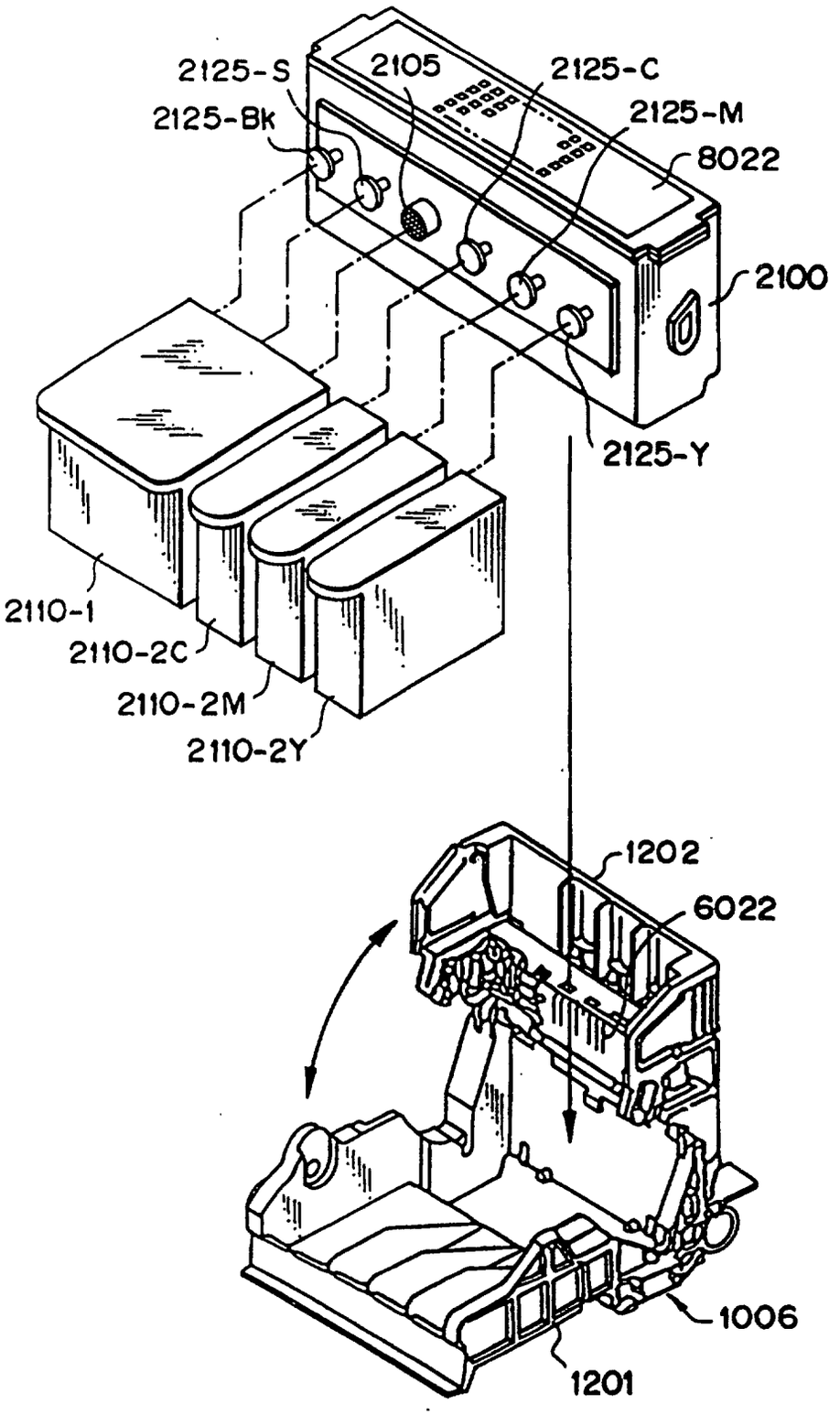

2125-S
2105
2125-C
2125-Bk
2125-M
8022
2100
2125-Y
2110-1
2110-2C
2110-2M
2110-2Y
1202
6022
1006
1201

FIG.13

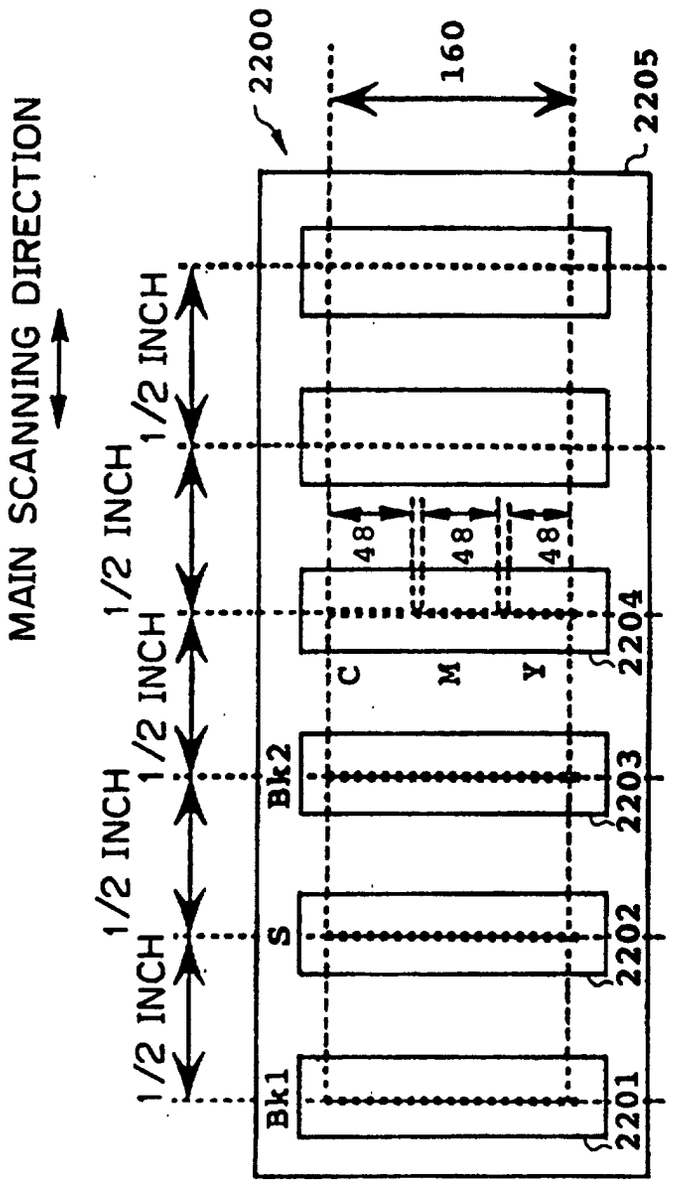

MAIN SCANNING DIRECTION
1/2 INCH
1/2 INCH
1/2 INCH
1/2 INCH
1/2 INCH
2200
160
2205
48
48
48
C
M
Y
2204
Bk2
2203
S
2202
Bk1
2201

FIG. 14

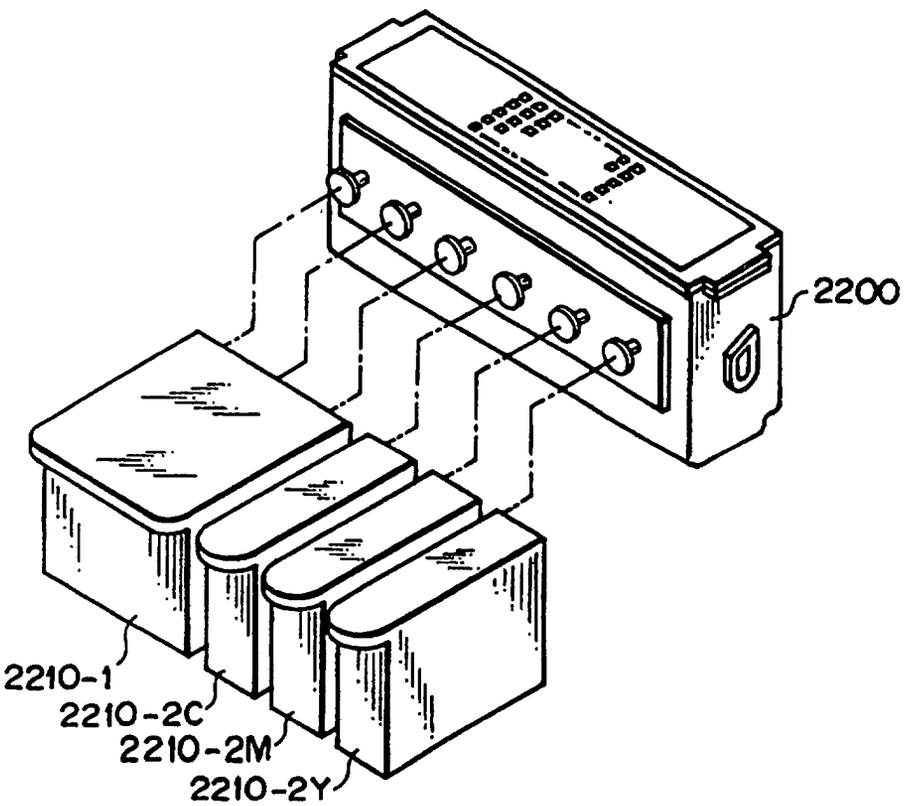


FIG.15

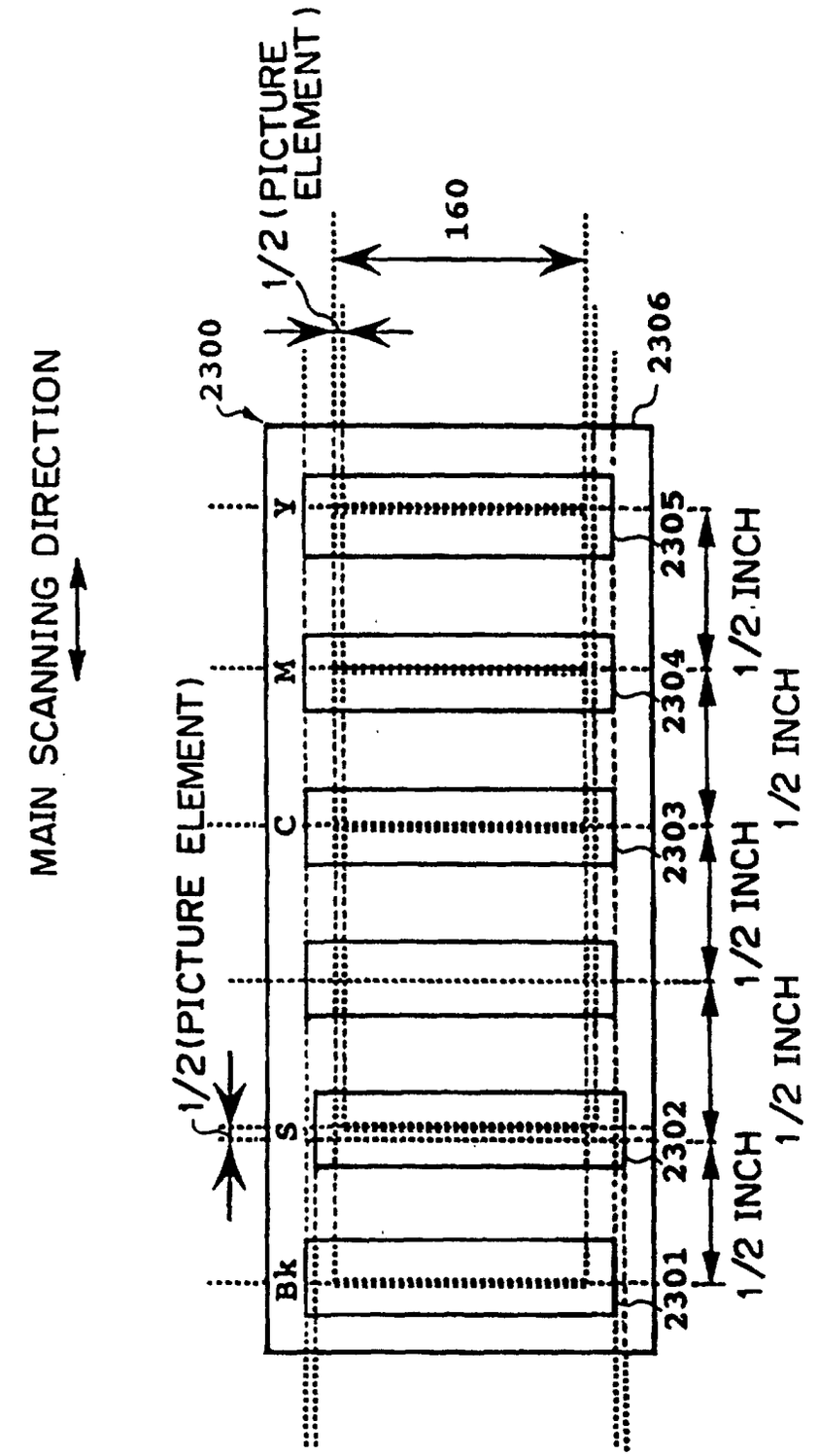

MAIN SCANNING DIRECTION
1/2(PICTURE ELEMENT)
1/2(PICTURE ELEMENT)
160
2300
2306
Y
M
C
S
Bk
2305
2304
2303
2302
2301
1/2 INCH
1/2 INCH
1/2 INCH
1/2 INCH
1/2 INCH

FIG.16

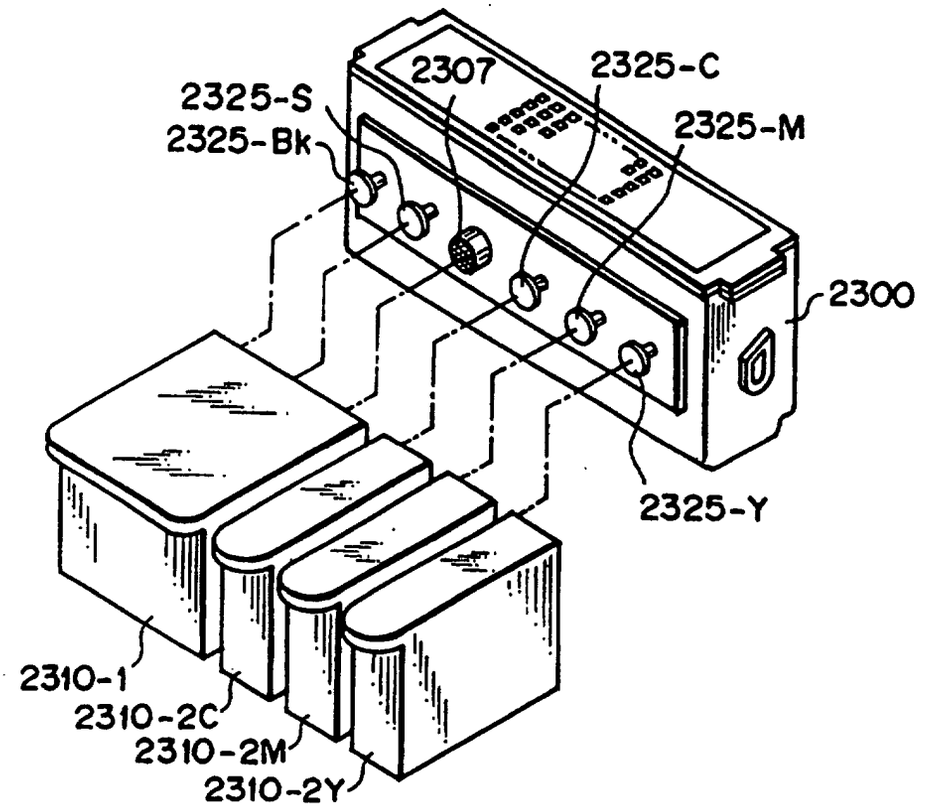

2307
2325-C
2325-S
2325-Bk
2325-M
2300
2325-Y
2310-1
2310-2C
2310-2M
2310-2Y

FIG.17

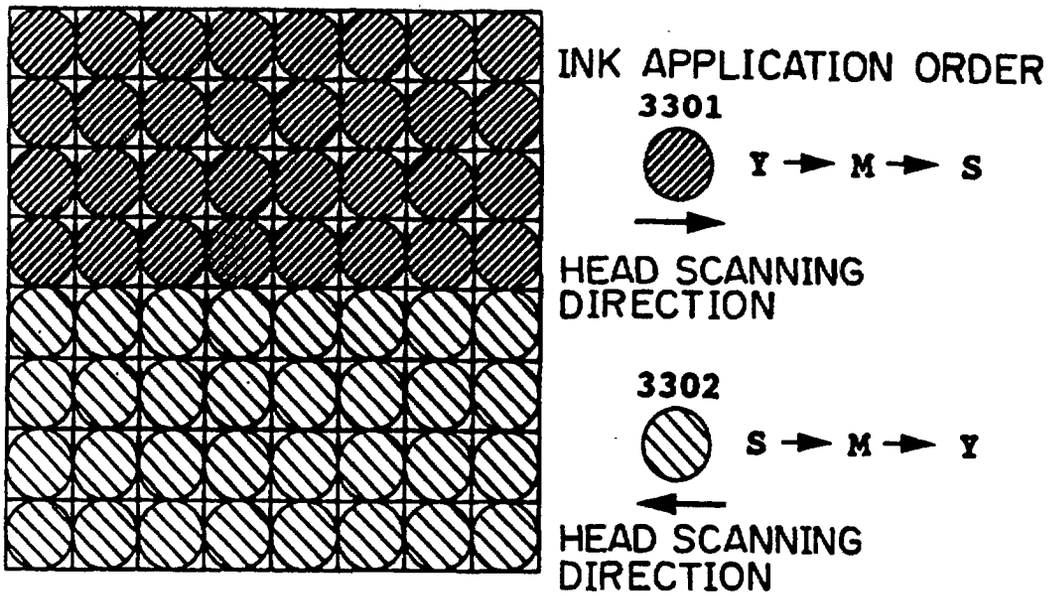


FIG.18A

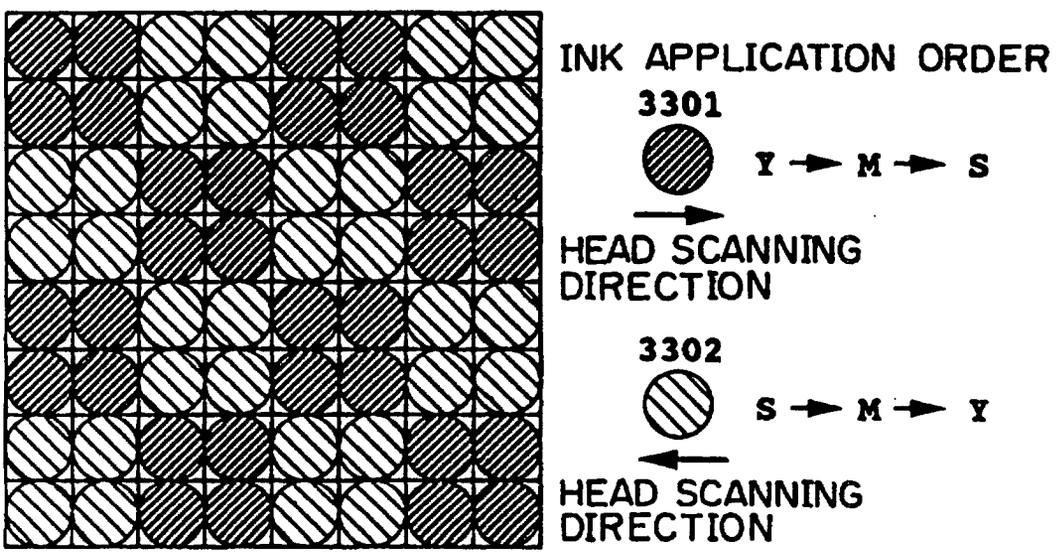


FIG.18B

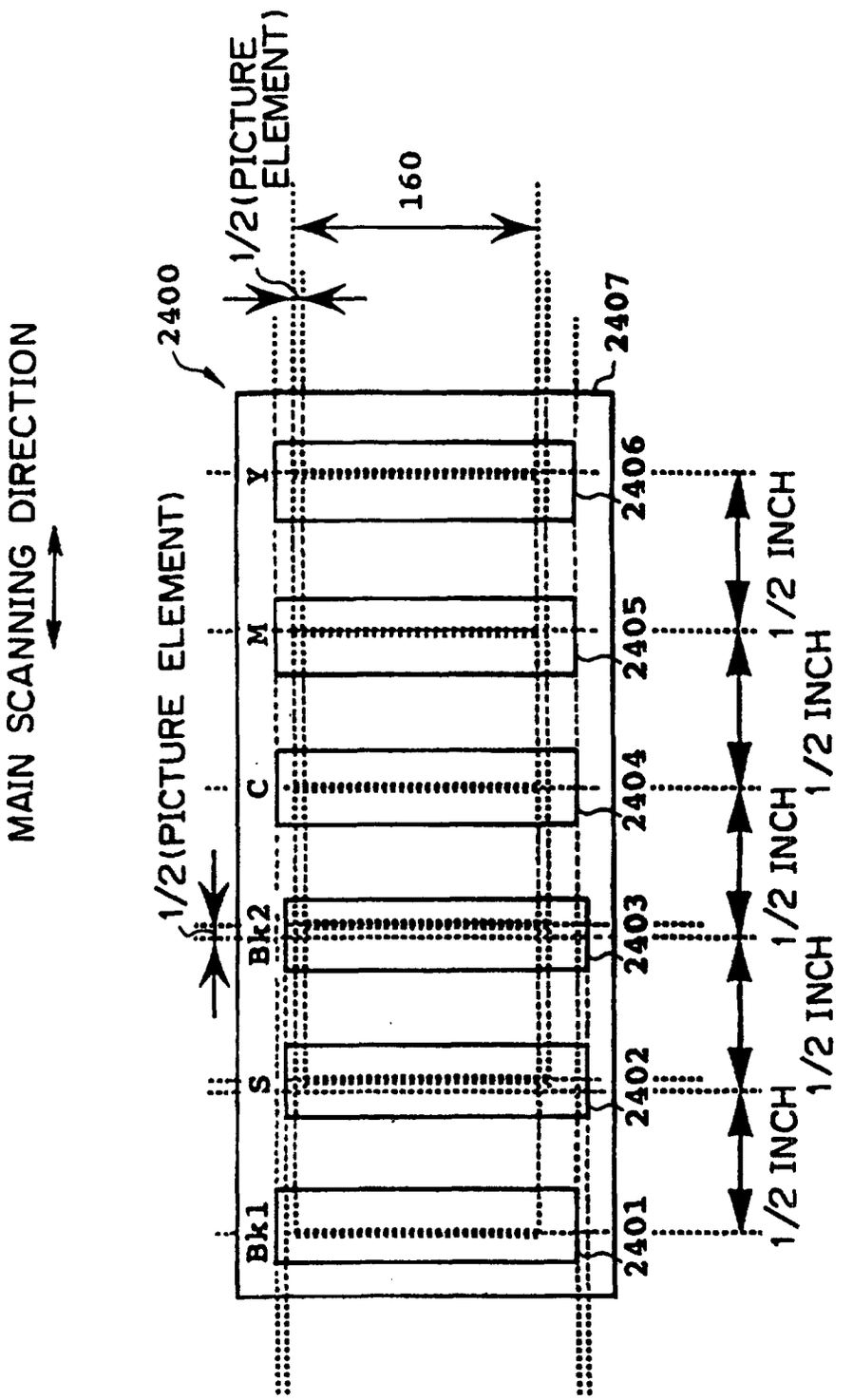

MAIN SCANNING DIRECTION
2400
1/2(PICTURE ELEMENT)
160
1/2(PICTURE ELEMENT)
2407
Y
M
C
Bk2
S
Bk1
2406
2405
2404
2403
2402
2401
1/2 INCH
1/2 INCH
1/2 INCH
1/2 INCH
1/2 INCH

FIG. 19

FIG.20A

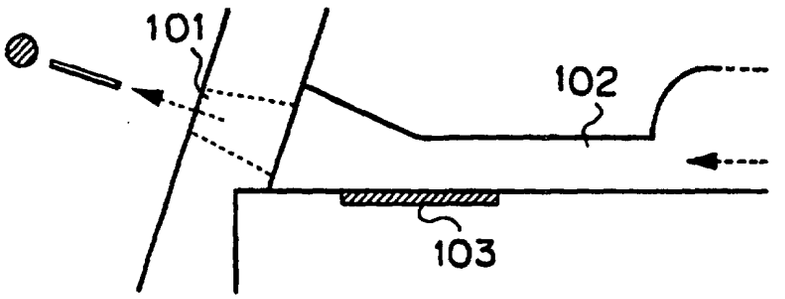


FIG.20B

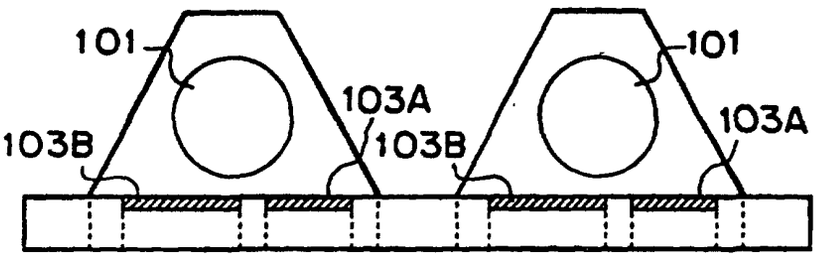
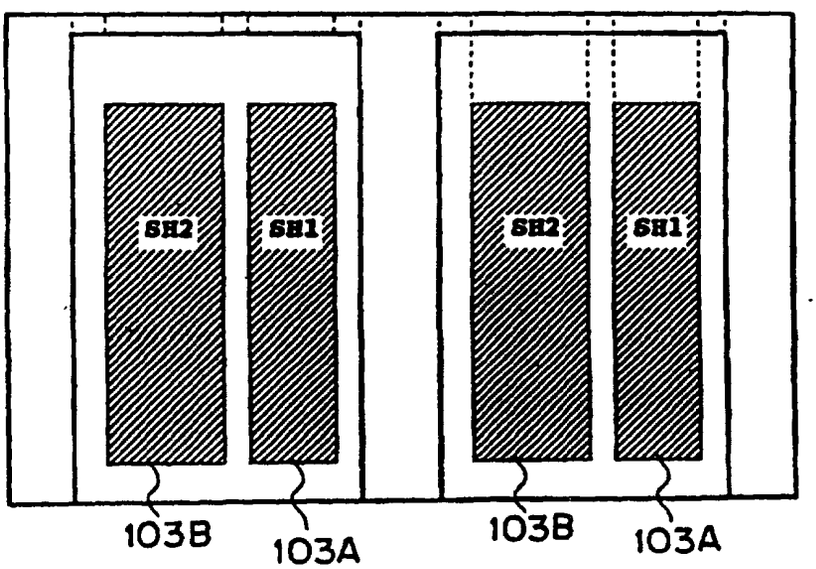


FIG.20C



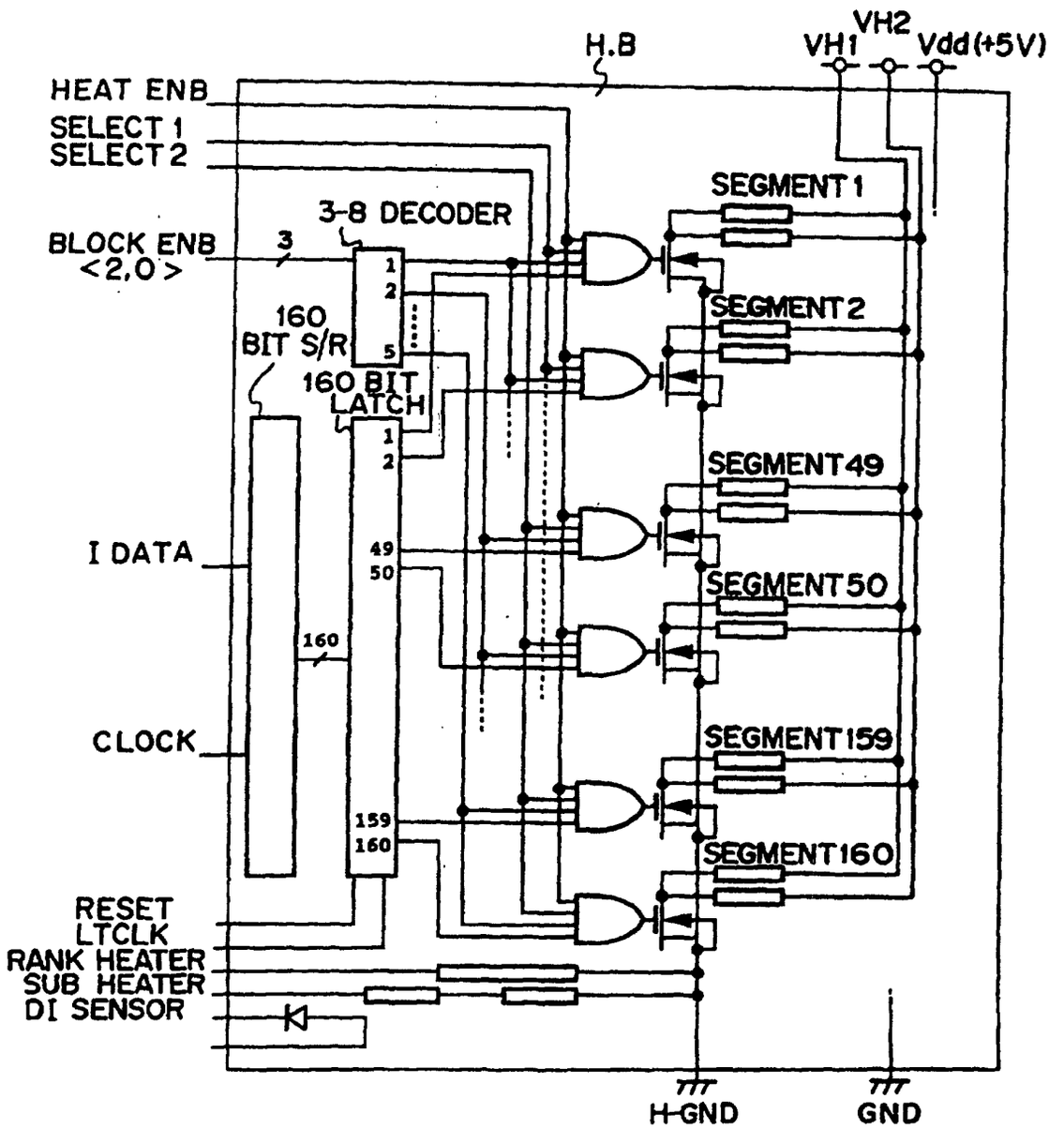

H.B
VH2
VH1
Vdd(+5V)
HEAT ENB
SELECT 1
SELECT 2
3-8 DECODER
BLOCK ENB
<2,0>
3
1
2
5
160
BIT S/R
160 BIT
LATCH
SEGMENT 1
SEGMENT 2
SEGMENT 49
SEGMENT 50
SEGMENT 159
SEGMENT 160
I DATA
49
50
160
CLOCK
159
160
RESET
LTCLK
RANK HEATER
SUB HEATER
DI SENSOR
H-GND
GND

FIG.21

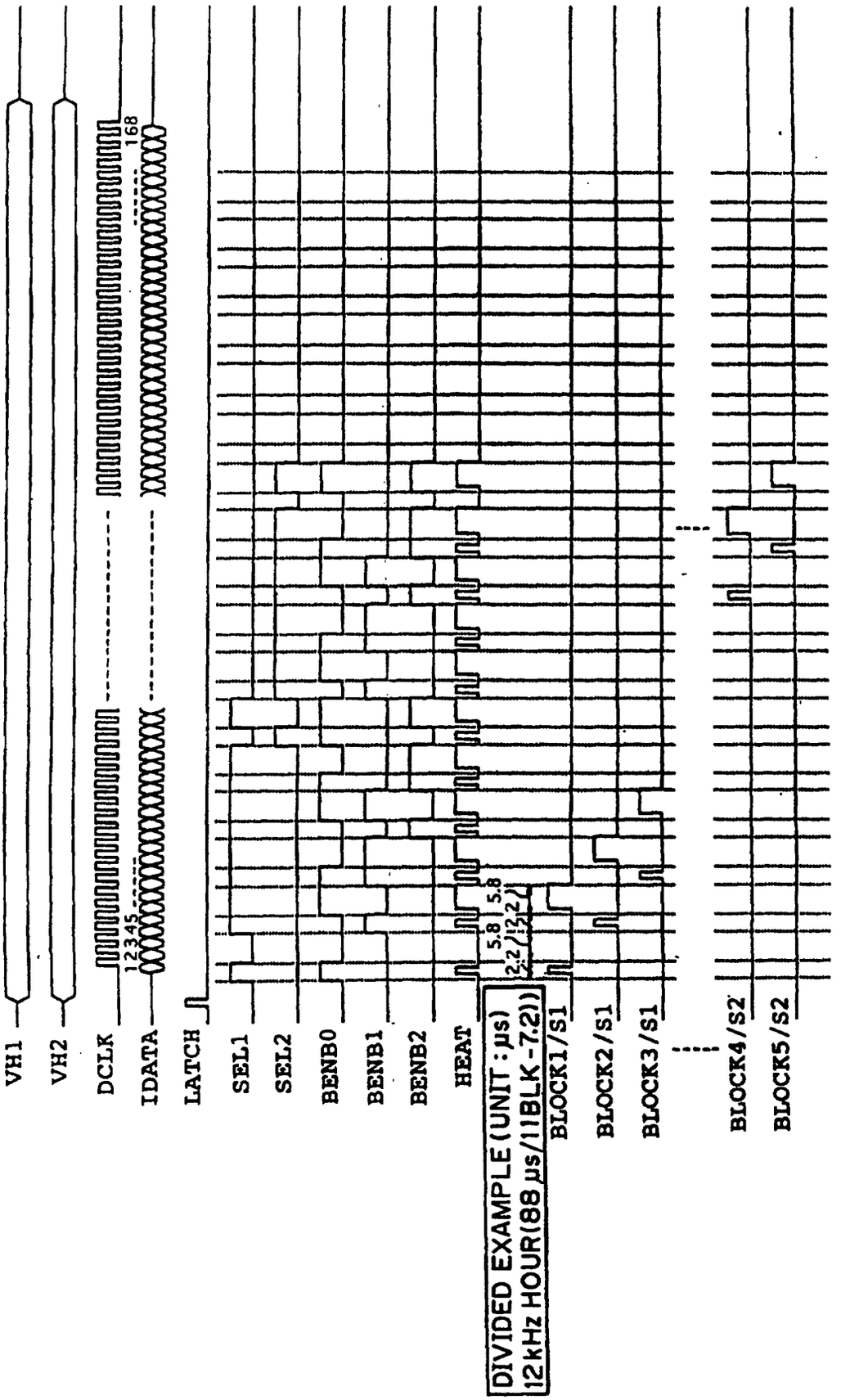

VH1
VH2
DCLK
IDATA
LATCH
SEL1
SEL2
BENB0
BENB1
BENB2
HEAT
1
2
3
4
5
168
5.8
2.2
5.8
2.2
DIVIDED EXAMPLE (UNIT : µs)
12kHz HOUR(88 µs/11BLK-7.2))
BLOCK1/S1
BLOCK2/S1
BLOCK3/S1
BLOCK4/S2
BLOCK5/S2

FIG.22

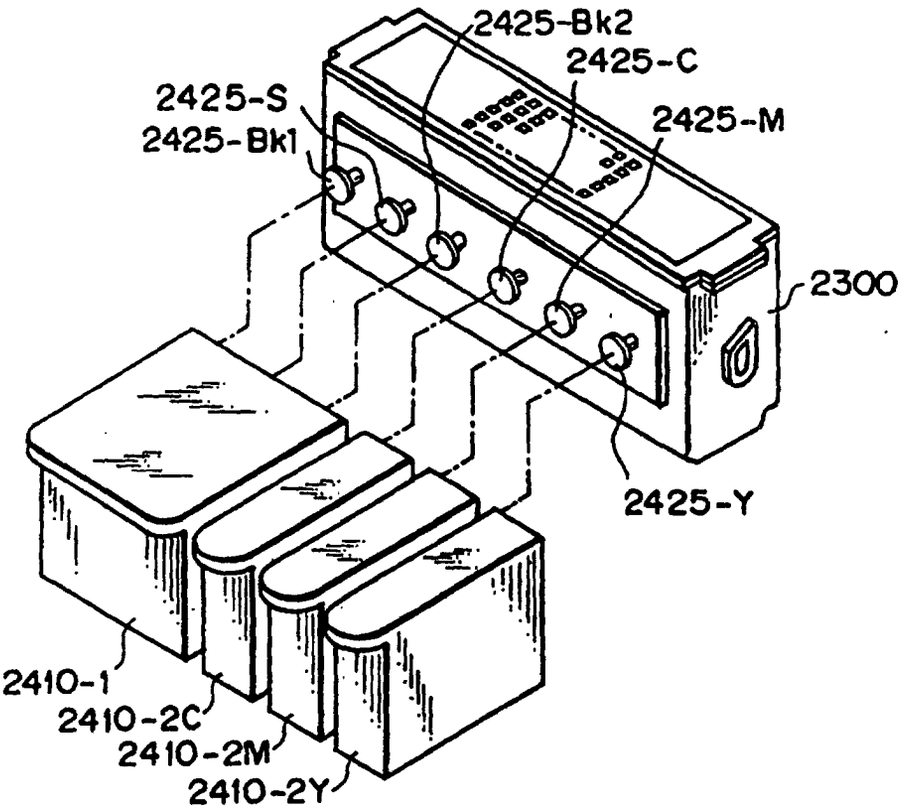

2425-Bk2
2425-C
2425-S
2425-M
2425-Bk1
2300
2425-Y
2410-1
2410-2C
2410-2M
2410-2Y

FIG.23

〈BRIEF DESCRIPTION OF PRINT MODE DISCHARGE AMOUNT RATIO (LARGE, MIDDLE AND SMALL DISCHARGE AMOUNT RATIOS =40:25:15)//(LARGE, MIDDLE AND SMALL DISCHARGE AMOUNT RATIOS =70:45:25)〉

WHEN THE NUMBER OF HEADS IS 5 TO 6

IN EMBODIMENT 5
(Bk x2 HEAD SHIFTED BY HALF PICTURE ELEMENT)
FOR 6 HEADS

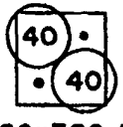
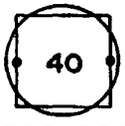
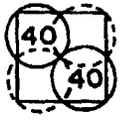
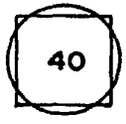
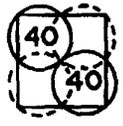
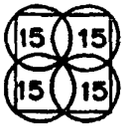
PRINT MODE	PRINT PASS Bk	PRINT PASS Col	DOT ARRANGEMENT Bk	DOT ARRANGEMENT Col
FAST	1-PASS BIDIRECTIONAL	1-PASS BIDIRECTIONAL	 720x360-h	 360x360
NORM. 300dpi	2-PASS BIDIRECTIONAL	2-PASS BIDIRECTIONAL	 720x360-h	 360x360
720dpi	2-PASS BIDIRECTIONAL	2-PASS BIDIRECTIONAL (SHIFTED BY HALF PICTURE ELEMENT)	 720x720-h	 720x720-h
HQ	4-PASS BIDIRECTIONAL	4-PASS UNIDIRECTIONAL (SHIFTED BY HALF PICTURE ELEMENT)	 720x720-f	 720x720-f

FIG.24

〈BRIEF DESCRIPTION OF PRINT MODE DISCHARGE AMOUNT RATIO (LARGE,MIDDLE AND SMALL DISCHARGE AMOUNT RATIOS =40:25:15) // (LARGE,MIDDLE AND SMALL DISCHARGE AMOUNT RATIOS =70:45:25)〉

WHEN THE NUMBER OF HEADS IS 5 TO 6

IN EMBODIMENT 4
(Bk x 1 HEAD)
FOR 5 HEADS

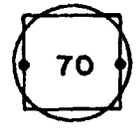
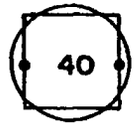
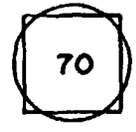
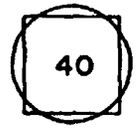
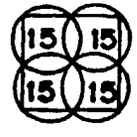
PRINT MODE	PRINT PASS Bk	PRINT PASS Col	DOT ARRANGEMENT Bk	DOT ARRANGEMENT Col
FAST	1-PASS UNIDIRECTIONAL	1-PASS UNIDIRECTIONAL	 360x360	 360x360
NORM. 300dpi	2-PASS UNIDIRECTIONAL	2-PASS BIDIRECTIONAL	 360x360	 360x360
720dpi	2-PASS UNIDIRECTIONAL (SHIFTED BY HALF PICTURE ELEMENT)	2-PASS BIDIRECTIONAL (SHIFTED BY HALF PICTURE ELEMENT)	 720x720-h	 720x720-h
HQ	4-PASS UNIDIRECTIONAL (SHIFTED BY HALF PICTURE ELEMENT) (4-PASS PRINT)	4-PASS UNIDIRECTIONAL (SHIFTED BY HALF PICTURE ELEMENT) (4-PASS PRINT)	 720x720-f	 720x720-f

FIG.25

EP 0 726 155 B1

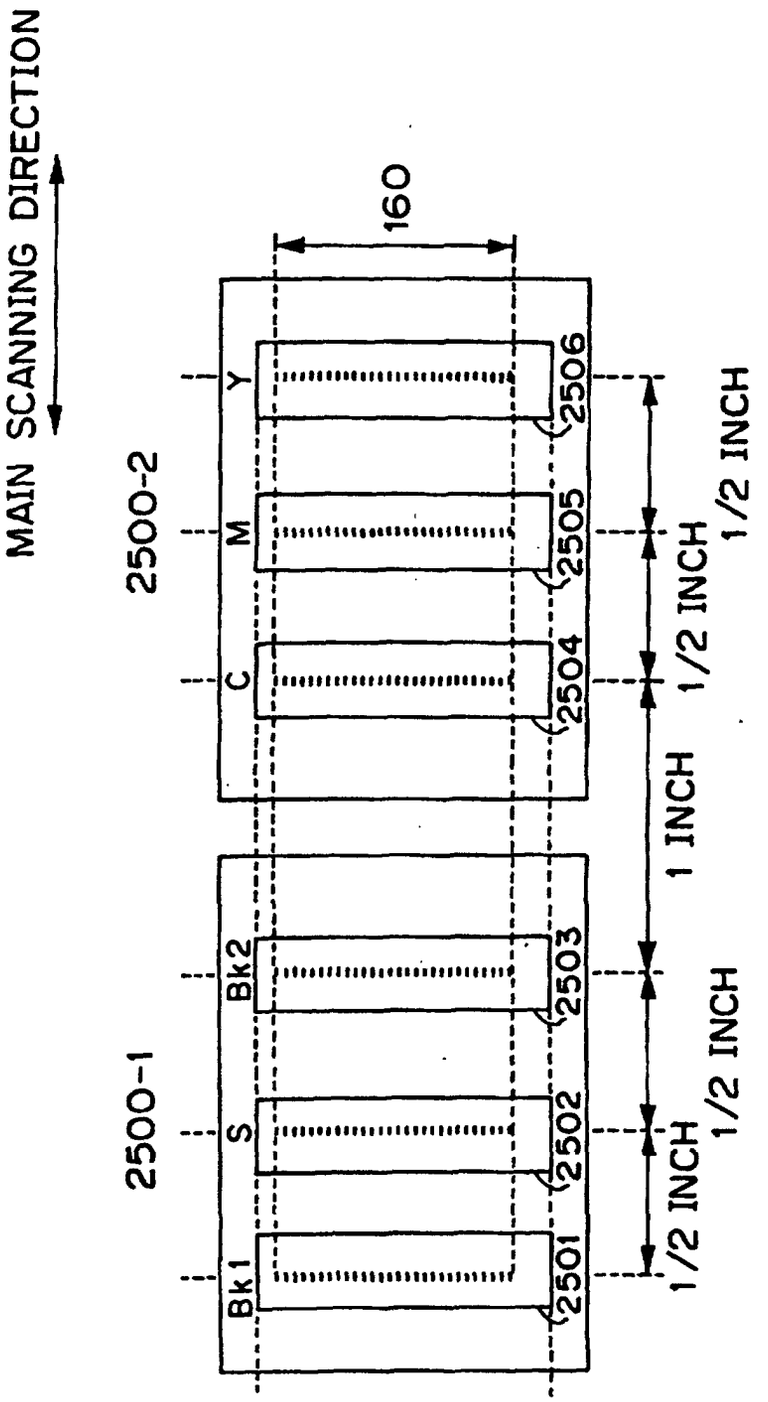

MAIN SCANNING DIRECTION
160
2500-2
2500-1
Y
M
C
Bk2
S
Bk1
2506
2505
2504
2503
2502
2501
1/2 INCH
1 INCH
1/2 INCH
1/2 INCH
1/2 INCH

FIG.26

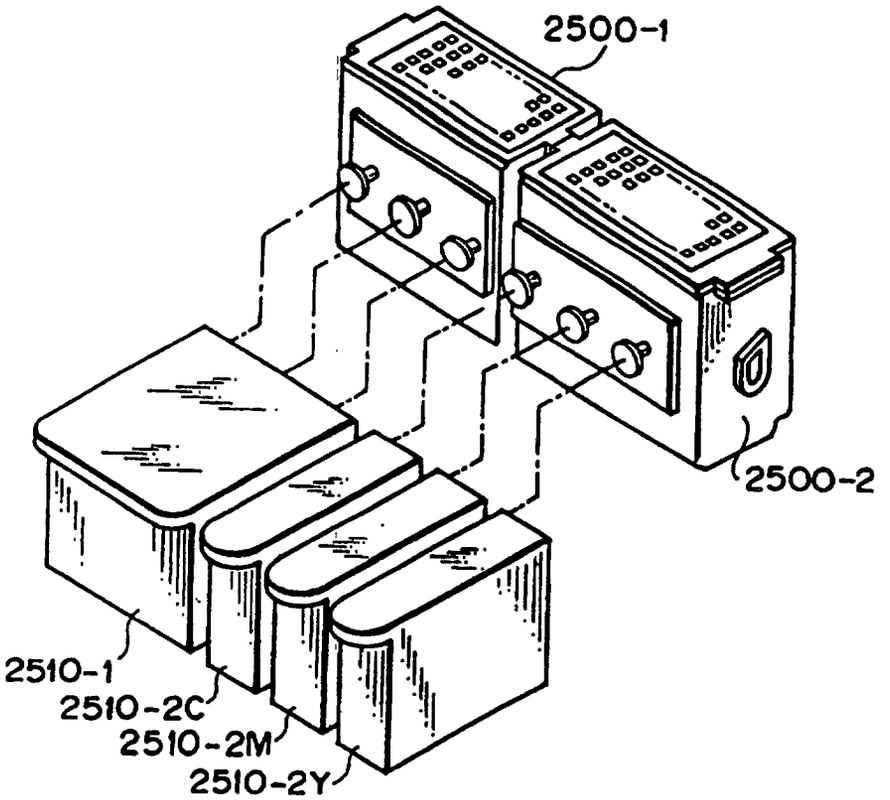


FIG.27

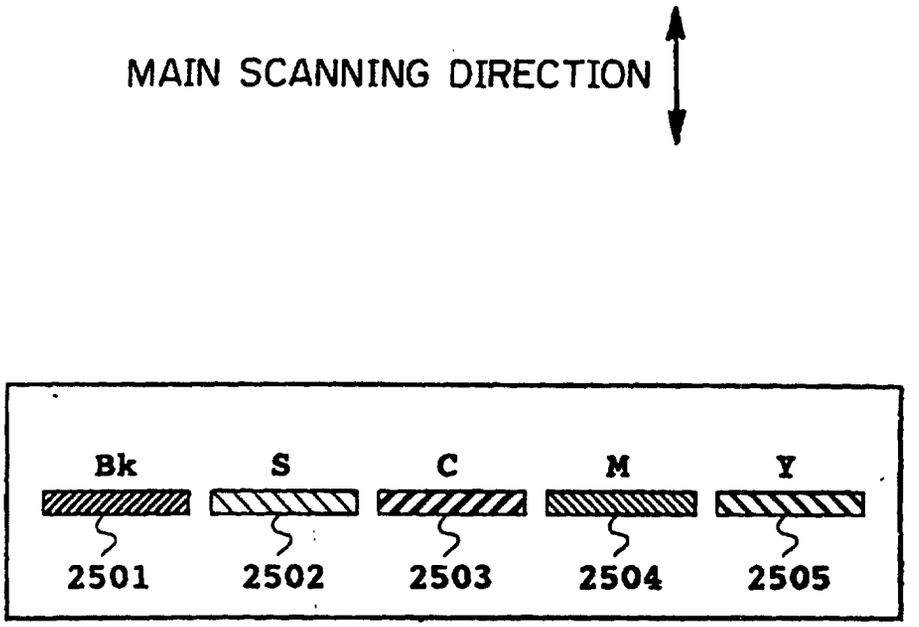

MAIN SCANNING DIRECTION
Bk
S
C
M
Y
2501
2502
2503
2504
2505

FIG.28

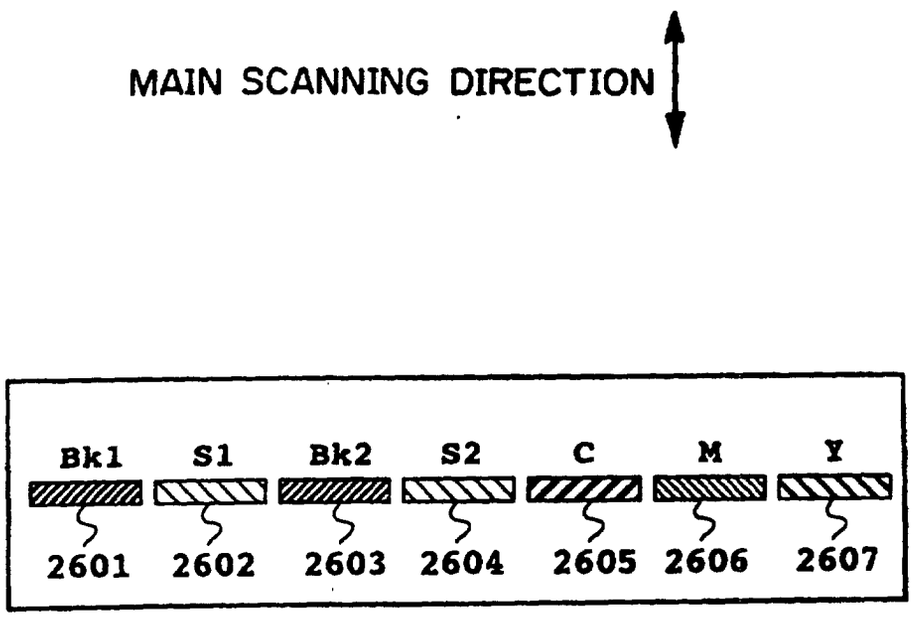

MAIN SCANNING DIRECTION
Bk1
S1
Bk2
S2
C
M
Y
2601
2602
2603
2604
2605
2606
2607

FIG.29

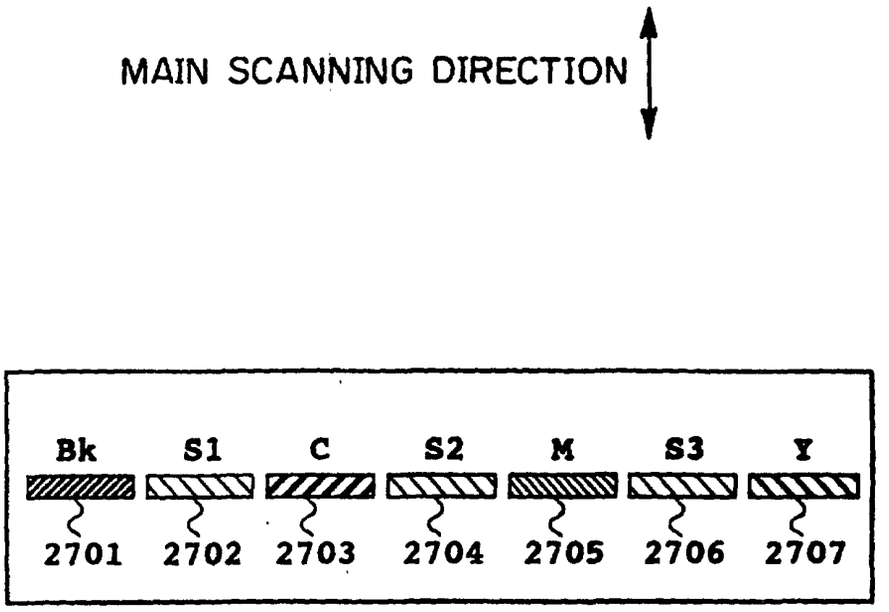

MAIN SCANNING DIRECTION
Bk
S1
C
S2
M
S3
Y
2701
2702
2703
2704
2705
2706
2707

FIG.30

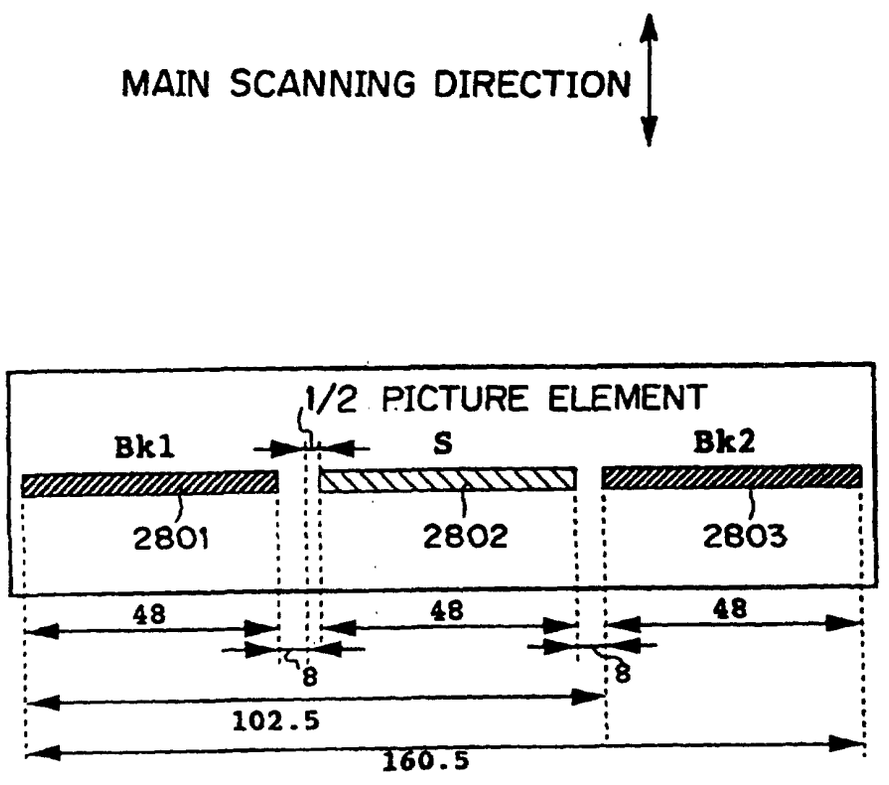
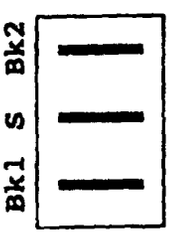
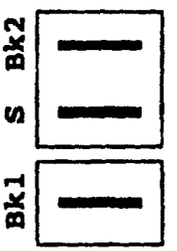

MAIN SCANNING DIRECTION
1/2 PICTURE ELEMENT
Bk1
S
Bk2
2801
2802
2803
48
48
48
8
8
102.5
160.5

FIG.31



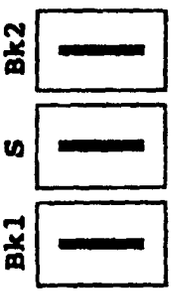
3-CHIP INTEGRAL TYPE
(EMBODIMENT 1)

FIG.32A



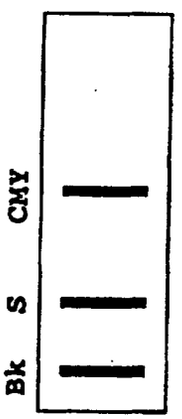
2-CHIP INTEGRAL TYPE
+1 CHIP

FIG.32B



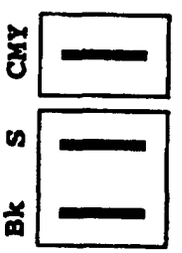
3-CHIP INDEPENDENT TYPE

FIG.32C



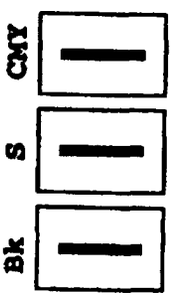
3-CHIP INTEGRAL TYPE
(EMBODIMENT 2)

FIG.33A



2-CHIP INTEGRAL TYPE
+1 CHIP

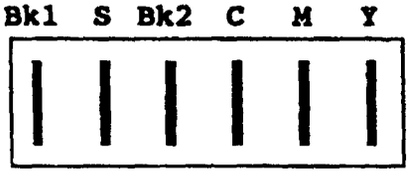
FIG.33B



3-CHIP INDEPENDENT TYPE

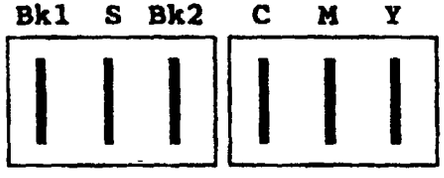
FIG.33C

FIG.34A



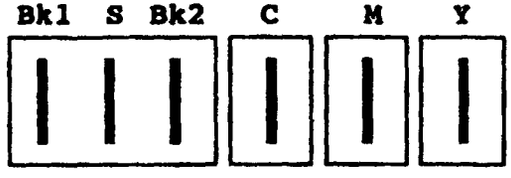
6-CHIP INTEGRAL TYPE
(EMBODIMENT 2)

FIG.34B



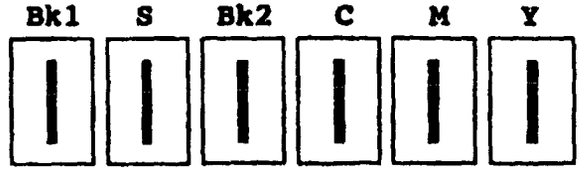
3-CHIP INTEGRAL TYPE
+3-CHIP INTEGRAL TYPE

FIG.34C



3-CHIP INTEGRAL TYPE
+3-CHIP INDEPENDENT TYPE

FIG.34D



6-CHIP INDEPENDENT TYPE

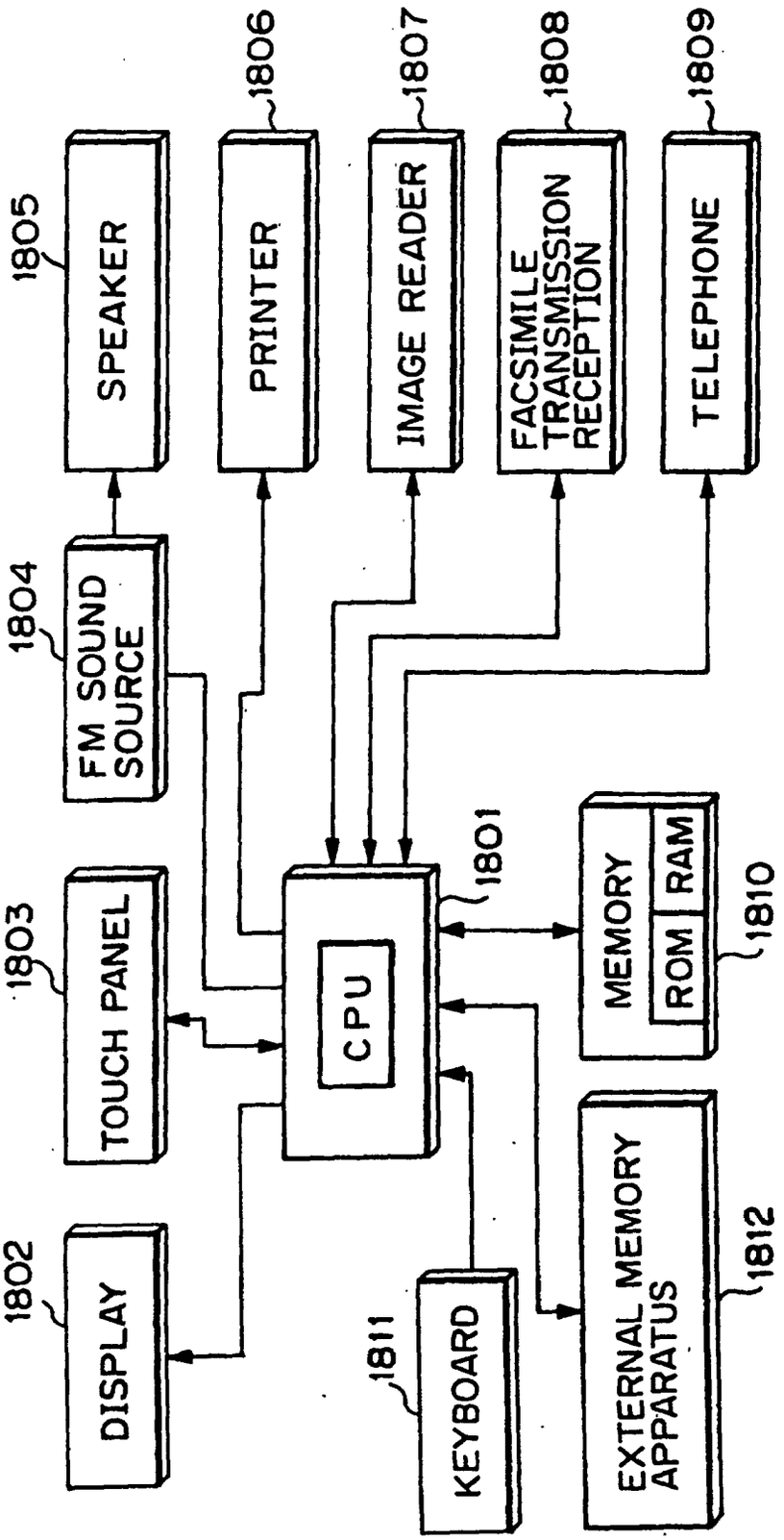

1805
SPEAKER
1806
PRINTER
1807
IMAGE READER
1808
FACSIMILE TRANSMISSION RECEPTION
1809
TELEPHONE
1804
FM SOUND SOURCE
1803
TOUCH PANEL
1802
DISPLAY
CPU
1801
MEMORY
ROM
RAM
1810
1811
KEYBOARD
EXTERNAL MEMORY APPARATUS
1812

FIG. 35

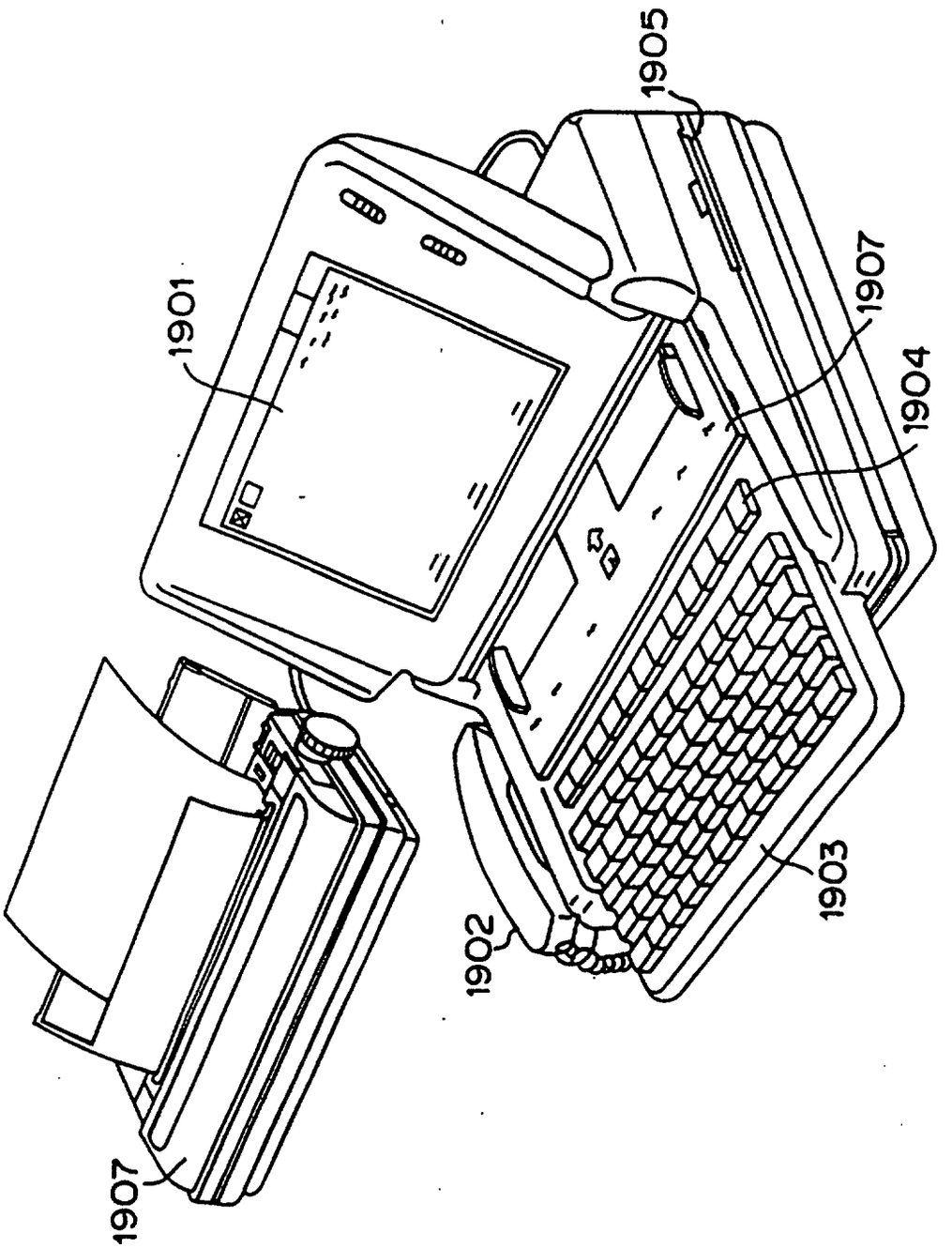


FIG.36

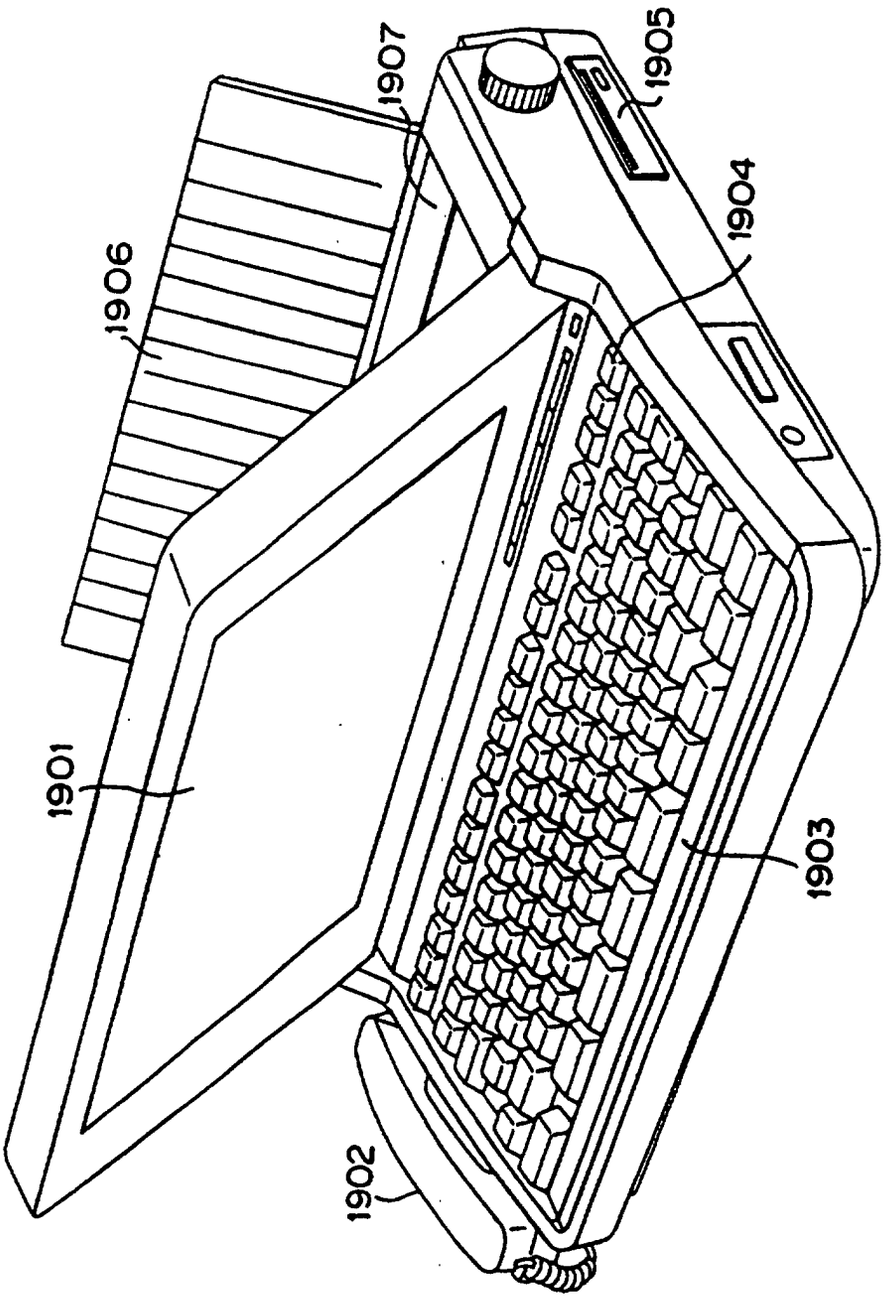


FIG.37